NATURE

No. 4334 SATURDAY, NOVEMBER 22, 1952 Vol. 170

CONTENTS

	Page
Preservation of Geological Sites: Bilston Glen	855
Horses. By Prof. D. M. S. Watson, F.R.S.	856
Progress in Nuclear Science. By Dr. W. D. Allen	857
Land Reclamation. By G. V. Jacks	858
The Hormones	858
The Phase Rule. By Prof. J. R. Partington, M.B.E.	859
Colour. By Dr. S. Clay	859
Agricultural Phytopathology. By Dr. S. G. Jones	860
Electron Microscopy of Solid Surfaces. By Dr. V. E. Cosslett	861
Cytochemical and Cytological Studies of Drug Action. By Prof. J. F. Danielli	863
Fibres, Old and New. By Dr. D. W. Hill	865
Antibiotics in Animal Nutrition	868
News and Views	870
Universities and University Colleges in Great Britain	873
Electrical Engineering in Britain	874
Plasticity of Materials. By Dr. A. J. Kennedy	875
British Electronic Instruments in Research and Industry. By Dr. J. A. Saxton	877
Medical Research Council: Report for the Year 1950–51. By Dr. G. Lapage	878
Photography in Research at the University	879
Fulmer Research Institute: Open Day	880
Indian Association for the Cultivation of Science	881
The Chayen Process for Extraction of Oils and Fats. By Dr. J. M. Coulson	881
Letters to the Editors:	
Extractability of the Lotmar–Picken Material from Dried Muscle.—Dr. H. E. Huxley and Dr. J. C. Kendrew	882
Is α-Keratin a Coiled Coil?—F. H. C. Crick	882
An Easily Used Ultra-Violet Microscope Objective.—Dr. M. H. F. Wilkins and K. P. Norris	883
Magnetostrictive Effect and the △-E Effect in Nickel.—Henrik Nödtvedt	884
Ultra-Violet Band System of Strontium Oxide (SrO).—Gunnar Almkvist and Dr. Albin Lagerqvist	885
Spectrum of the Compton Radiation from Solids.—Kessar Alexopoulos and Gösta Brogren	886
Fate of Sodium 2,4-Dichlorophenoxy-ethyl-sulphate in the Soil.—Prof. L. J. Audus	886
β-Oxidation of ω-Phenoxyalkylcarboxylic Acids in the Flax Plant.—C. H. Fawcett, J. M. A. Ingram and Prof. R. L. Wain	887
Hydrolysis and Metabolism by Soil Bacteria of Benzoyl Derivatives of D- and L-Forms of some Amino-acids.—Prof. Yukio Kameda, Etsuko Toyoura, Hiroshi Yamazoe, Yukio Kimura and Yoshiro Yasuda	888
Soil Bacteria and Chlamydospore Formation in *Fusarium solani*.—C. S. Venkat Ram	889
Growth-Factor Requirements of *Pellicularia koleroga* Cooke in Pure Culture.—K. T. Mathew	889
Influence of Mineral Nutrition on the Resin Content of the Hop Cone.—F. C. Thompson and Dr. A. H. Burgess	890
A Factor in Hay inhibiting the Action of Vitamin D.—J. Weits	891
Corticium praticola Kotila; an Interesting Basidiomycete occurring in England.—N. T. Flentje	892
Isolation of Triploid *Saccharomyces cerevisiae*.—Seymour Pomper	892
Apparent Fumigant Action of Non-volatile Insecticides in African Huts.—G. Davidson and G. F. Burnett	893
An Extended Orcinol Test Specific for Ketose Sugars.—J. Howarth Williams	894
A Sparing Effect by Formate or Methanol on the Impairment of Creatine Metabolism in Folic Acid Deficiency.—Prema Fatterpaker, Urmila Marfatia and Dr. A. Sreenivasan	894
Response of the Vaginal Epithelium of the Ovariectomized Mouse to the Systemic and Local Administration of Œstrone.—J. D. Biggers	895
Two Forms of 1 : 2 : 3 : 5 Tetra-Acetyl D-Ribofuranose.—Kathleen R. Farrar	896
Disadvantages of Race Mixture.—Prof. R. Ruggles Gates, F.R.S.	896

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
J. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

PRESERVATION OF GEOLOGICAL SITES

BILSTON GLEN

"THE geologist is concerned fundamentally with observation, that is, with the systematic recording of phenomena as they present themselves to him"; so commented Dr. J. E. Richey in his presidential address to Section C (Geology) of the British Association at the recent Belfast meeting (*The Advancement of Science*, 9, No. 34, 122; September 1952). For this reason the geologist must continually be returning for study to the rock exposures that provide him with the material for his 'patterns of evidence'. The importance of preserving, so far as possible, geological sites of outstanding scientific and educational value was recognized by the Council of the eighteenth session of the International Geological Congress, by a unanimous recommendation, endorsed by the General Assembly of the Congress on August 30, 1948, to the governments of all countries represented at the Congress, to take legislative action, if they had not already done so, to safeguard such sites and to secure reasonable access to them[1].

The geological record has often been compared with an obscure and mutilated document, from the surviving remnants of which the geologist must piece together, as best he may, the history of the earth. Here and there natural sections yield exceptionally clear narratives of episodes in that history, and it is such sections that it is especially important to preserve as standards of comparison with more fragmentary records.

Such a standard section has been provided by the Bilston Burn where, about five miles south-south-east of the centre of Edinburgh, but less than a mile from the city boundary, it crosses the upturned strata on the western flank of the Midlothian syncline. Rising east of the Pentland Hills, the Bilston Burn passes under the Edinburgh to Peebles road at Bilston and enters a ravine which, about a mile farther east, attains a depth of about 150 ft. This ravine has come to be called the Bilston Glen; but the old name for it is Dryden, and this is the name by which it was known to Sir Walter Scott, who for a few years lived at Lasswade, in the same parish. Hugh Miller described it thus: "There is not a prettier dell in the south of Scotland than that of Dryden. . . . Dryden is a winding valley overhung by precipitous banks and stately wood, that opens into the wider valley of the Esk, and exposes, in its course, a series of strata singularly interesting to the geologist"; and, again: "I have already referred to the Marine Limestones of Dryden,—one of the best sections of the formation as developed in Scotland which I have anywhere seen"[2].

Dryden, or Bilston Glen, still retains much of its charm, and since Hugh Miller's time it has been frequently resorted to by geologists wishing to study the Scottish development of the Carboniferous rocks, not only from the Edinburgh district but also from all parts of Great Britain and from foreign countries.

Indeed, a geological excursion to the Edinburgh district can scarcely be considered complete without a visit to the Bilston Burn. Its easy accessibility and proximity to Edinburgh have made it especially valuable for demonstration to university students. The range of Carboniferous strata exposed in the glen is unrivalled by any other inland section in Scotland and by few elsewhere in Great Britain. This is due to the prevailing high easterly dip, which averages more than 45°, the Bilston Burn crossing the outcrops nearly at right angles to the strike. Thus, in the stretch of about a mile and a quarter east of the Edinburgh–Peebles road, the strata traversed by the Bilston Burn range from the top of the Calciferous Sandstone Series, through the Lower Limestone, Limestone Coal and Upper Limestone Groups, into the Millstone Grit (Roslin Sandstone), comprising a thickness of nearly 3,400 ft. of beds. Though more spectacular, not even the famous section of the Avon Gorge at Bristol reveals so great a thickness, or a much greater stratigraphical range, of Carboniferous strata.

Exposures in the Bilston Glen are not continuous; but they are sufficiently numerous for a tolerably complete record to have been compiled over the years during which the section has been studied—a record, however, which is even now being amended and added to. Many fossiliferous bands have been located and collected from, and among the most interesting are those in the lower part of the Millstone Grit, the fossils of which closely resemble forms found in the Coal Measures of Nebraska and Illinois, from which circumstance the assemblage has been called the 'Nebraskan Fauna'[2]. The known fossil horizons in the Bilston Glen include nearly all those named bands which serve as index beds in the Scottish Lower Carboniferous sequence; but the presence of some of these bands has only quite recently been established. A natural section such as this, with an active stream and unstable banks, must change somewhat from decade to decade; hence, so long as the glen remains accessible, there will always be the possibility of new discoveries.

The Bilston Glen, then, provides a type section with which to compare the variations of the Lower Carboniferous sequence elsewhere in Scotland. This is not only important from the purely scientific point of view, but is also of great practical value for the mining industry, for the comparison can be made with sections in mine-roads and with the cores of exploratory borings. The utility of such a type section in the training of students who may later apply their stratigraphical knowledge to the solution of mining problems should require no emphasis.

Nevertheless, more than half of this type section is threatened with obliteration. A new colliery, named (perhaps with unconscious irony) "Bilston Glen Colliery", is being sunk on the north side of the Bilston Glen to work the large reserves of coal in the Limestone Coal Group of the district, and it has been planned to dispose of the spoil by filling up the adjacent Glen. Since, in the late summer of 1950, this project became generally known, protests against the spoliation of the Bilston Glen have been registered by scientific bodies, including the Geological Societies of Edinburgh, Glasgow and London and the British Association for the Advancement of Science. Mindful, no doubt, of the threatened loss of a feature of natural beauty in an area already losing its rural character, the Association for the Preservation of Rural Scotland supported the protest made by the Edinburgh Geological Society. Further, the Nature Conservancy took up the cause of the Bilston Glen in an endeavour to secure its conservation as a Nature reserve.

So far, however, these efforts seem to have resulted in no more than a temporary and partial reprieve. By a decision of the Minister of State for Scotland, made in March of this year, the National Coal Board has been given permission to use part of the Glen for the dumping of colliery refuse during the next ten or fifteen years. At the end of this period the possibility of transferring dumping to another site is to be considered; but, if this is found to be impracticable, the Coal Board is to be allowed to use an adjacent part of the Glen, farther down stream, and will be asked to consider whether a third portion, west of that to be used first, could also be filled in with spoil. If it is not thought practicable to use another site for dumping now, it is, perhaps, scarcely likely that it will seem more practicable ten or fifteen years hence, when the Coal Board has already been using part of the Bilston Glen for that period. The Minister's decision thus seems virtually to condemn a large portion of the Glen to destruction. This includes what is, perhaps, the most valuable part of the geological section, comprising more than 2,000 ft. of strata and including the whole of the Lower Limestone and Limestone Coal ("Edge Coal") Groups.

All this part of the Bilston Glen would scarcely accommodate as much as half the total amount of spoil that it is estimated will be produced during the hundred years life of Bilston Glen Colliery. Sooner or later, then, some other means of disposing of the refuse must be devised. Is it too much to hope that, even now, more far-sighted counsels may prevail, and that the picturesque Dryden, with its classic geological section, may be spared for posterity?

[1] International Geological Congress. Report of the Eighteenth Session, Great Britain, 1948; Part 1, General Proceedings, 1950; p. 180.

[2] Miller, Hugh, "Edinburgh and its Neighbourhood, Geological and Historical", pp. 71 and 85 (posthumously published, fourth edit., Edinburgh, 1870).

[3] Hind, W., "The Lamellibranch and Gastropod Fauna in the Millstone Grit of Scotland", *Trans. Roy. Soc. Edin.*, **46**, 332 (1908).

HORSES

Horses

The Story of the Horse Family in the Modern World and through Sixty Million Years of History. By George Gaylord Simpson. Pp. xxiv+247+32 plates. (New York and London: Oxford University Press, 1951.) 40*s.* net.

So much of human history has been determined by the existence of domesticated horses that these animals have gained a unique place in folk-lore and in the affections of many men. The horse was apparently domesticated early (probably many times) in the area of distribution of wild horses from Europe to China, and it is probable that selective breeding

has long been practised to produce horses fit not only for ordinary life, but also for war. Arabs and Genghis Khan s 'Golden Horde' owed their conquests to well-designed cavalry tactics, and these were dependent on speed and toughness.

Of such specialized breeds the most distinguished is the Arabian. Long inbred in the desert, with pedigrees carefully kept, the Arab horse played its essential part in the development of the Thoroughbred; and the Thoroughbred horse has contributed to light horses all over the world.

G. G. Simpson gives in this book a very condensed but admirable account of the domestic horses, especially of Britain and the United States. He then passes on to consider the colour of horses, especially in American use where there are names—Pinto, Appaloosa and Palomino—which are strange to an Englishman. A Palomino is a horse with a silver mane and tail and a golden body, its body shape being undefined; none the less, Dr. Simpson points out that two independent associations, of the nature of breed societies, exist in the United States. It seems very doubtful if the Palomino colour can exist in a homozygous form; it is normally heterozygous and cannot breed true. Simpson gives a very simple and clear account of the genetics of the condition as determined by W. E. Castle.

From here the book goes on to describe the history of the horse in geological time. The first attempt to do so was in 1872 when T. H. Huxley brought together *Palæotherium*, *Anchitherium*, *Hipparion* and *Equus* as animals which, put in the order of age, formed a graded series in the structure of their teeth and feet; and he suggested that this might be a real example of the evolution of an animal. A year later Kovalevsky, after a much more detailed study, agreed with Huxley and in 1876 carried the matter still further, still using European materials. In fact, none of these animals is in the direct line of the horse; they are aberrant lateral twigs, which nevertheless conform in many characters to true horse ancestors of the same, or often a slightly earlier, stage. Actually, in 1874, O. C. Marsh, of Yale University, claimed to have a series of fossils which lay in the direct line of descent and supplied every important form. In 1876 Marsh demonstrated these materials to Huxley, who immediately accepted his conclusions.

Since then, immense collections of fossil horses and horse ancestors have come from all the continents except Australia, and nearly all vertebrate palæontologists have published something about them. Under the influence of H. F. Osborn, the American Museum of Natural History became the great centre of work on these animals, and for many years W. D. Matthew's little guide to the Museum collection has been the best account of the whole story. This booklet, now out of print, is obsolete, and in the present very readable volume Dr. Simpson gives a most admirable account of the whole history—not of course in detail, for that would mean many thousands of pages of text and of figures, but in outline. He considers not only the actual structural changes, but also the functional effect of these changes in increasing the weight which can be supported by the food which can be ground up by the dentition, and the significance of the structural changes in the feet.

The book is thus authoritative, wide-ranging and easy to read, and it should be read by everyone who is interested in evolution and the mechanism by which it has been brought about. D. M. S. WATSON

PROGRESS IN NUCLEAR SCIENCE

Annual Review of Nuclear Science

Vol. 1. Pp. x+645. (Stanford, Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1952.) 6 dollars.

ONE index of the increase in the rate of accumulation of scientific information is the post-war efflorescence of reviews and surveys. In physics alone, for example, there have appeared "Progress in Metal Physics", "Progress in Biophysics", "Progress in Cosmic Ray Physics", and so on. Annual Reviews, Inc., of Stanford, California, have for some time published "Annual Reviews of Biochemistry"; now a new series commences, the "Annual Review of Nuclear Science".

The objective of the editors is the preparation of a series of annual review volumes covering the most important developments in the field of nuclear science each year. For the first year (1950), they have certainly cast their net wide. Thus, while about half the book is devoted to physical topics, the other half includes the separation of stable isotopes; metallurgy; actinide elements, and analytical nuclear chemistry; radioisotopes in chemical systems, in biochemical research and in soils research; geochemistry; stable isotopes in biochemical research; and the genetic and biological action of radiation. Of these, some (especially the article on progress in metallurgy) are clear and concise; but in general the articles are too technical to satisfy the average physicist, while probably not detailed enough to satisfy, say, the plant biologist who would otherwise feel that the book is heavily weighted in favour of the other sciences. A better approach might be to restrict individual volumes to individual fields of nuclear science.

The volume, therefore, is presented to that versatile individual, the nuclear scientist, and one might expect the level of the average essay to be that of postgraduate standard. The approach of the various authors, however, varies widely. Thus, on one hand, the article on energy-levels of light nuclei goes to the length of explaining the meaning of the notation $^7\mathrm{Li}(dz)^6\mathrm{He}$; whereas, on the other hand, that on the theory of nuclear structure is addressed to the specialist rather than to the general reader.

Nevertheless, the general impression is that the venture is successful and the effort well worth while. The volume makes an excellent start with an article on meson physics, which is an admirable survey of the subject; supported later by one on the nuclear interaction of cosmic rays. Stable isotopes are discussed in three articles, and high-energy accelerators in five; the essay on the detection of nuclear particles is concise and practical. That on nuclear moments is a little disappointing—one feels that a fascinating field is rather summarily dismissed. In contrast, the article on atomic and molecular spectroscopy is a clear exposition of recent developments in a well-ploughed field. Finally, there is an essay on low-temperature phenomena, which is perhaps an interloper in a volume on nuclear science; but it is so well written, in its sketch of background and review of recent development, that its inclusion is amply justified.

The format is excellent and errors few. No British reader, however, will fail to be interested to learn (p. 178) that a 140-MeV. synchrotron is under construction at "Oxford University, Cambridge, England". W. D. ALLEN

LAND RECLAMATION

Reclaiming Land for Agriculture

By Moses Griffith, J. F. H. Thomas and R. Line. (Agricultural and Horticultural Series.) Pp. 119+16 plates. (London: Crosby Lockwood and Son, Ltd., 1951.) 12*s*. 6*d*. net.

TO those who can recall the time when meat, cheese and eggs were basic articles in the Englishman's diet, this book will bring hope that their children may live to see those conditions restored. The wastage of our greatest, and potentially inexhaustible, source of wealth—the land—is a national scandal. Mr. Moses Griffith estimates that there are five million acres of hill and moorland alone in Britain "capable of very substantial improvement", and he and Messrs. J. F. H. Thomas and R. Line show that the task of reclamation with modern implements and technique would not be difficult on the hill land, the chalk land and the fen and silt land which they respectively discuss.

Sir George Stapledon, in a comprehensive introduction, points to the very high cost of land reclamation and emphasizes the economic importance of regional planning, and of intensive study of plant and animal ecology, not forgetting human requirements; for unless men and women find social satisfaction on the reclaimed land, it will revert to waste. It is to be hoped that a people which spent nearly £40 million on almost fruitless land reclamation in East Africa will not be deterred by the initial cost from replenishing its larder from its own soil.

It is on the intrinsically infertile, and often inaccessible, hill lands that the economic factor is most intractable. The crawler tractor and other machines have, however, greatly facilitated the task of cultivation, and the aeroplane should equally help to solve the problem of fertilizing these lime- and phosphate-starved soils. Work at Aberystwyth has shown that remarkable improvement can often be effected by ploughing and reseeding with improved herbage, usually after a pioneer crop like rape which is grazed to provide dung and consolidation of the soil by stock. Mr. Griffith leaves the impression that, although many intricate questions remain unanswered, enough success has already been achieved to make very large-scale reclamation of hill land a practical proposition now.

Reclamation of chalk land presents rather easier problems. Much of the land has been highly farmed with sheep in the past and has only recently become partly or completely derelict. Considerable areas were cultivated to exhaustion during the First World War, and these could be restored to productivity fairly easily with adequate fertilizing. Among the major tasks are the clearance and disposal of scrub growth on abandoned land, much of it of high productivity, and the restoration of the rich valley pastures. There is scope for intensification of both arable and livestock farming, and the appropriate land management is better understood than is the case on mountainous hill land.

In the Fen country "the cost of reclamation of the fen is not such an important consideration as the returns per acre that can be expected from this very exceptional soil". Around the Wash there are a hundred square miles of this country awaiting enclosure and development. Good drainage is the key to fenland farming, and much reclaimed land has been allowed to go derelict through neglect of drains. Methods of reclamation and management are well understood, and what are chiefly needed are men, money and machinery. It is to be hoped that the Government will give high priority to this first line of defence—at least as vital to our security as rearmament, for the imperative need to grow our own food will always remain, whatever the international outlook.

G. V. Jacks

THE HORMONES

A Symposium on Steroid Hormones

Edited by Edgar S. Gordon. Pp. xiii+396. (Madison, Wis.: University of Wisconsin Press, 1950.) 6.50 dollars.

Recent Progress in Hormone Research

The Proceedings of the Laurentian Hormone Conference. Vol. 5. Edited by Gregory Pincus. Pp. viii+537. (New York: Academic Press, Inc., 1950.) 8.80 dollars.

The Hormones

Physiology, Chemistry and Applications. Edited by Gregory Pincus and Kenneth V. Thimann. Vol. 2. Pp. ix+782. (New York: Academic Press, Inc., 1950.) 12.50 dollars.

Vergleichende Physiologie

Von Prof. W. von Buddenbrock. Band 4: Hormone. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften: Reihe der experimentellen Biologie, Band 9.) Pp. 492. (Basel: Verlag Birkhäuser, 1950.) 47.50 Swiss francs.

THE first three of these four volumes were published in the United States in 1950, and to some extent cover the same ground. The fourth is a German work which deals with less-recent endocrinological knowledge.

The "Symposium on Steroid Hormones" is a report of a conference which took place at the University of Wisconsin in 1949, and is concerned with the chemistry, biosynthesis and metabolism of steroid hormones and with their physiological effects. Some of the facts presented at the conference have not previously been published, so that, in addition to a general review, the volume edited by Dr. E. S. Gordon will need to be referred to as a source book of original observations. The ground covered by the contributors to "Recent Progress in Hormone Research", Vol. 5, which is a report of the proceedings of the Laurentian hormone conference for 1949, is much the same as that which was explored at the Wisconsin conference for 1949, and again a large number of the contributions deal to a considerable extent with new observations.

Neither of these meetings was concerned to cover the whole field of hormone research. This is the purpose of the two volumes published under the title of "The Hormones", and edited by Gregory Pincus and Kenneth V. Thimann. Vol. 1 appeared in 1948 and dealt with plant hormones; hormones in invertebrates; the internal secretion of the pancreas; and various aspects of the steroid hormones, as well as with the chemistry of the anterior pituitary hormones. Vol. 2 deals with the physiology of ovarian hormones; of androgens; of the adrenal cortex; of the thyroid; of the pituitary hormones; as well as with the chemical control of nervous activity; and concludes with a section on clinical endocrinology. In their preface, the editors point out that any work in which separate sections are contributed by

different experts runs a risk of being disproportionate in its emphasis. While admitting this danger, they also suggest that the two volumes for which they are responsible nevertheless provide a fairly complete presentation of the subject "at the research level". They can be confident that this is so, and students of endocrinology are greatly in their debt for having undertaken so formidable a task.

Vol. 4 of "Vergleichende Physiologie", by Prof. W. von Buddenbrock, of the University of Mainz, is in an entirely different class. Its purpose is not clearly stated, and it is far less comprehensive in its references to modern literature than any one of the three American volumes referred to above. It is the fourth of a series on comparative physiology, of which the first two were written before the Second World War, and the third was in the press when the War began. The present volume was undertaken at a time when the author did not have access to work that was being carried out either in Great Britain or in the United States, and was brought 'up to date' during only a five-week stay in Switzerland, when Prof. von Buddenbrock had access to the more recent literature. Although published in 1950, the result is that there is an almost negligible record of work published after 1946. The book has a zoological, as opposed to an endocrinological or clinical, orientation, and will be of value to research workers in American and British laboratories who wish to obtain a synopsis of endocrinological research carried out on the Continent of Europe up to the year 1939.

THE PHASE RULE

Principles of Phase Equilibria

By F. E. W. Wetmore and D. J. LeRoy. (International Chemical Series.) Pp. x+200. (London: McGraw-Hill Publishing Co., Ltd., 1951.) 30*s*.

The Phase Rule and Heterogeneous Equilibrium

By Prof. John E. Ricci. Pp. xi+505. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1951.) 90*s*. net.

THE introduction of the phase rule into chemistry dates from 1884, when Bakhuis Roozeboom, working in the laboratory of van Bemmelen in Leyden on hydrates of sulphur dioxide, had his attention directed by van der Waals to a rather obscure and brief passage in a paper by Willard Gibbs, published in 1876, which contains the key to the systematic study of heterogeneous equilibria. Since then it has proved of inestimable service in many fields. The first intelligible account of it was given by Roozeboom, and the clear survey by Findlay is still one of the best books for the student. The two books here under review are intended to help students to understand and appreciate what is undoubtedly one of the major branches of physical chemistry. Many find the subject rather unattractive in comparison with other fields of study, since it offers no scope for hypotheses and does not involve what may be called modern aspects of the science, based on new knowledge of atomic and molecular structure. Still, no one can afford to neglect a subject which can and does play an important part in chemical industry, and a good book on it should always find a welcome.

F. E. W. Wetmore and D. J. LeRoy's book is concerned mainly with fundamental principles, presented in a form based on experience and making no use of thermodynamics. It is intended for students in other subjects, such as arts and engineering, as well as chemical students. The treatment is elementary, and the bright students may find parts of it rather dull, since some points which may be almost obvious are dealt with in some detail. It does, however, reach four component systems, and there is a brief appendix on the thermodynamic basis of the phase rule and on partial molar quantities. The book is sound, but seems to have no obvious superiority over existing ones.

The book by J. E. Ricci, who is an authority in the field, is more ambitious and detailed, and hence, probably, more attractive. It begins with a thorough examination of the basis of the phase rule which all readers will find interesting. It is, however, doubtful if much more has been added to the clarification of the well-known difficulty of the definition of the number of components of a system. This is purely a matter of mathematical book-keeping, and most teachers find that the more this is emphasized and the less concession is made to beginners who feel that they ought to have some 'reasons' given them, the quicker the pace in learning. Another point is the introduction of continuous miscibility at the start, heterogeneous systems with pure phases being brought in as special cases. This is done in some other books, and not all will agree that it is the best way of beginning the subject. It may be the ideal way; but that is a different matter. The book deals with all the important aspects of the subject in a masterly way, and will be regarded as an authoritative monograph. All the important methods of graphical treatment are explained, and I have missed nothing which could be expected to be found in an advanced book. The diagrams are clear and attractive. I think that the subject is best taught in relation to actual systems, and this is done in the book. It makes the subject more real to the student and makes him aware of its value and scope, so that he takes an interest in what might otherwise be rather formal and dull to him. This book is certain to become a standard and should be sure of a warm welcome by those who can afford it. J. R. PARTINGTON

COLOUR

Colour

In Theory and Practice. Edited by H. D. Murray. A new edition, revised, enlarged and re-written by R. Donaldson, V. J. Francis, P. Holliday, R. G. Horner, N. Laycock, L. C. Thomson, G. T. Winch, and the Editor. Pp. xiii+360+27 plates. (London: Chapman and Hall, Ltd., 1952.) 70*s*. net.

IT is thirteen years since the first edition of "Colour" appeared (see *Nature*, 144, 227; 1939), and the present book differs very considerably from the original. Mr. H. D. Murray has enlisted seven collaborators instead of his original one. A medical man, for example, has rewritten the chapters concerning the anatomy and physiology of the human eye, and included new material to give a more comprehensive survey. Other specialists have similarly revised and extended the treatment of their own fields.

The consideration of the fundamental physical and chemical aspects of radiation comprises a little less than one-third of the text. Here the authors have devoted some space to atomic physics as a background, and have gone somewhat outside the strict limits of 'colour'. The book has gained rather than lost by this liberal interpretation of the subject,

which is also apparent in other places, but some such title as "Visible Radiation" might, therefore, have been more appropriate. In the review in *Nature* of the first edition, it was suggested that the survey of coloured substances could advantageously have been combined with the chapter on the chemistry of colour, but it is now even more completely divorced, as an appendix. Chemical indicators are barely mentioned, despite their great interest.

Human vision, and subjective aspects of light and colour, are accorded an even more expanded treatment. As many workers in other branches of science, and in commerce and industry, never aspire to more precise colorimetric tools than colour charts, further considerations of the limitations and virtues of the popular colour dictionaries would have been welcome.

The third section is highly technical, discussing light sources from sun to candle, from arcs to fluorescent lamps, and the complicated apparatus and methods of modern light and colour measurement. A penultimate chapter concerned with the psychology of colour follows as comparatively light relief.

A very few pages headed "Colour in Nature" are unworthy of the rest of the book; they provide not a single clue to the relevant botanical, and only three references to the zoological, literature. It is a pity that one or more biologists were not included in the team of authors.

The second edition of "Colour" includes most of the original matter, much rearranged, and a good deal of new text, with additional figures. (Although the first edition only claimed three colour plates to the eight of the present book, in fact both have the same number of coloured illustrations, and only two of these have been substituted.) Changes in terminology are to be noted, and the new Appendix 3 is a valuable extract of definitions, for the most part internationally accepted, from the Physical Society's 1948 Report on Colour Terminology. Separate bibliographies for each chapter now replace scattered references in the text—a great improvement. A dual pagination with index references on a chapter rather than book basis seems a needless irritation. The amplified and revised text is, of course, more up to date and satisfactory to the specialist, and more valuable to him as a work of reference; almost inevitably it has also become less easy to read for the non-physicist seeking a comprehensive guide to the whole field of colour.

The first edition was criticized as expensive at 25*s*. After making allowance for the augmented text (but smaller format and more ordinary binding), even by to-day's standards the new edition seems no cheaper.

S. Clay

AGRICULTURAL PHYTOPATHOLOGY

Disease in Plants

An Introduction to Agricultural Phytopathology. By the late Dr. Neil E. Stevens and Prof. Russell B. Stevens. (Manual of the Plant Sciences, Vol. 1.) Pp. xx+219. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson, Sons and Co., Ltd., 1952.) 4.75 dollars.

THIS manual, written by two distinguished American pathologists, father and son, is based on a series of lectures, planned as self-contained chapters, on the general principles of plant pathology. It does not treat of specific diseases and pathogens, but the entire subject-matter forms a comprehensive and valuable introduction to plant pathology designed, as the authors state, for the general reader as well as for the student and professional pathologist.

Stress is laid at the outset on the seriousness of the world food problem to-day, on measures of increased production and of possible preventable losses through disease control. These topics are discussed as part of the whole food situation in relation not only to food crops but also to the healthy production of timber stands and fibre plants as well.

Presumably for the benefit of the general reader, an early chapter (there are twenty in all) is devoted mainly to the anatomical structure and physiology of the healthy green plant, root, stem and leaf, this being followed by descriptions of pathological effects in these organs. The diagrams illustrating the normal anatomy are good and clear, but the same cannot be said of the few photomicrographs showing features of morbid anatomy.

Having already mentioned that bacteria and fungi are the principal instigators of disease, the authors, instead of first giving detailed consideration to these organisms, which are so easily demonstrable in affected tissues, proceed as early as in their third chapter to a consideration of viruses as agents of plant disease. Then follows a comparatively short account of bacteria and fungi, meagrely illustrated, this section closing with a table of classification of phytopathogenic forms. The occurrence, chemical nature, multiplication, mutation, transmission, symptoms, etc., of viruses and their effects are given brief but excellent treatment, this chapter being well illustrated in respect of symptoms of virus diseases. A section is also devoted to parasitic and hemiparasitic seed-bearing plants, and to injurious nematodes and insects. Excellent consideration again is given to nutritional and meteorological factors and to chemical injury in relation to the incidence of disease, with a full citation of relevant literature appended.

It is refreshing to find an entire section being devoted to the significance of such factors as the abundance and uniformity of the host plant when grown in close formation or pure stands, in contrast to growth in mixed culture as conducive to epidemic attacks; growing conditions—temperature, light and nutrition; and disease escape—resistance, tolerance and immunity. In the section on epidemiology, which may well have appeared earlier in the manual, the qualities, reproduction and dissemination of micro-organisms are treated, brief consideration being given to methods of host-penetration and survival of the pathogen; further discussion of the parasite in respect of variation and physiological specialization is resumed in later sections.

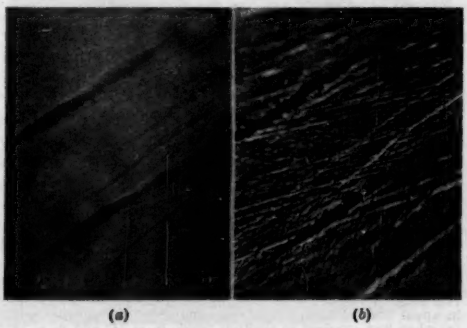
Eight chapters of the manual are devoted to the subject of disease control, embracing such topics as the economy of disease control, chemical treatment, seed and soil treatment, crop rotation, sanitation, breeding, 'market' pathology (harvest losses, low-temperature storage, care in handling) and the incidence of 'new' diseases. This excellent manual, apparently the first of a series on plant sciences, closes with a plea for greater public support of agricultural research and for the encouragement of intelligent co-operation between grower and pathologist as contributory in no small measure to the success of the world-wide campaign against food shortage and disease.

S. G. Jones

ELECTRON MICROSCOPY OF SOLID SURFACES

THE normal type of electron microscope allows specimens to be examined by transmission only. The possibility of image formation with electrons scattered from a solid surface was early investigated by Ruska and Müller[1], with normally incident electrons, and by von Borries[2] with grazing incidence. The latter method proved more effective and 'reflexion' micrographs were obtained from a variety of metal surfaces[3]. The development of replica techniques provided a simpler means of investigating topography, applicable in many circumstances, and the reflexion method was temporarily abandoned. However, the widening application of the electron microscope showed the need for a means of continuously observing a surface at high resolution—for example, under chemical treatment or at high temperature. In 1948 an investigation of the possibilities of the reflexion electron microscope was begun in several centres independently: in the U.S.S.R.[4], in the Cavendish Laboratory, Cambridge[5], and in the Engineering Laboratory, Cambridge (by a scanning method). Soon afterwards, the construction of a reflexion instrument was begun at Toulouse, and more recently at least two standard electron microscopes have been adapted to reflexion operation. The progress of most of these projects was reported at a special session of the meeting of the Electron Microscopy Group of the Institute of Physics, held at the H. H. Wills Physics Laboratory, University of Bristol, during September 16–19, which gave a convenient opportunity for assessing the potentialities of the reflexion technique. The parallel development of surface investigation by means of electrons emitted thermionically or photoelectrically was not surveyed, but it is useful to include here a method using ionic bombardment to excite emission.

In the 'reflexion' electron microscope only a small part of the electrons experience reflexion in the true sense, the majority being scattered irregularly from the irradiated surface. If the beam is incident at a grazing angle of a few degrees and the portion 'reflected' at a similar (but not necessarily identical) angle is collected in a system of electron lenses, as in a normal electron microscope, it is found that micrographs of good contrast can be obtained at a useful magnification of several thousand times. M. E. Haine, W. Hirst and A. E. Ennos (Associated Electrical Industries Research Laboratories, Aldermaston) discussed the scattering of electrons of the relevant speed (50–100 kV.) by a solid surface, with particular attention to angular distribution and energy loss. The latter is important, as it introduces a chromatic spread into the reflected beam, which severely restricts the attainable resolution owing to the large aberration of the lenses. From measurements of the unsharpness of the image at high magnification, the loss of energy ΔV was found to extend to about 150 V. With the type of objective lens and angular aperture used in transmission microscopy, the corresponding resolution would be about 400 A., but by using a very small aperture a value less than 50 A. might be attained. Exposure times would then become inconveniently long owing to the relative inefficiency of reflexion and the small aperture. At present, it can be kept to a few seconds by using a normal aperture and the most intense illuminating beam available.



(a) (b)

Fig. 1. Optically polished steel surface: (a) electron beam making an angle (θ_1) of 3° with the surface; (b) $\theta_1 = 0{\cdot}3°$. Transverse magnification × 2,100. (A.E.I. Laboratories, Aldermaston)

The distribution with scattering angle fell less rapidly than expected, falling to about 10 per cent at 10° to the surface. Hence the optical axis of the microscope can be sufficiently inclined to that of the illuminating system to avoid reception of the direct beam without undue loss of brightness in the image. When the surface is optically very smooth, it is found that best results are obtained with a small incident grazing angle ($\theta_1 < 1°$) and a moderate angle of view θ_2 (4°–10°). It is advisable to keep the latter as large as is compatible with exposure requirements, so as to minimize foreshortening of the image. Haine, Hirst and Ennos have investigated an optically polished steel flat, using an adapted Metropolitan-Vickers *EM*3 instrument with an electron gun of continuously variable tilt. Extremely fine detail becomes visible on reducing the grazing angle from 3° to 0·3° (Fig. 1). It is estimated that irregularities in height of the order of 40 A. should be directly detectable by this means. In the opening contribution, entitled "The Evaluation of Surface Topography", Hirst pointed out that surface relief of long period is readily revealed, which would not give adequate contrast by the replica method in transmission even if the field of view were sufficiently large. A crystallographically informative type of diffraction micrograph can be taken by selecting, with an aperture in the back focal plane of the lens, the diffracted beam corresponding to a true Bragg reflexion. A bright-field image of the correctly oriented crystals is then obtained, superimposed on the normal reflexion picture.

Prof. C. Fert (University of Toulouse) described a reflexion microscope in which the inclination of the beam is controlled with magnetic deflecting coils. It is designed to operate up to 250 kV. and has already been used at 100 kV.; an intermediate lens permits electron diffraction operation. The object holder allows every required motion of the specimen, including rotation in azimuth. A resolution approaching 500 A. has been obtained with an aperture of 5×10^{-3} (Fig. 2). He finds that better results are obtained at 100 kV. than at 50 kV., probably owing to the improved value of $\Delta V/V$, since ΔV does not depend on V so long as multiple collisions are not important. Prof. Fert discussed means of restoring

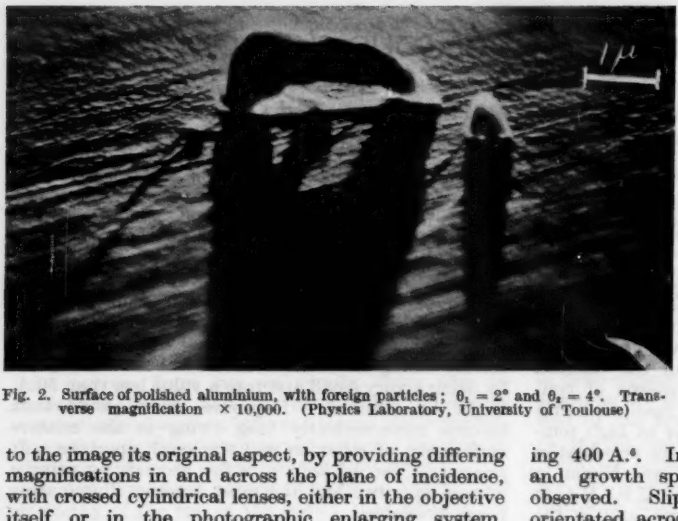


Fig. 2. Surface of polished aluminium, with foreign particles; $\theta_1 = 2°$ and $\theta_2 = 4°$. Transverse magnification × 10,000. (Physics Laboratory, University of Toulouse)

to the image its original aspect, by providing differing magnifications in and across the plane of incidence, with crossed cylindrical lenses, either in the objective itself or in the photographic enlarging system. Alternatively, the recording plate or the printing paper could be inclined to the optic axis in order to compensate the foreshortening.

A similar instrument built at the Cavendish Laboratory, Cambridge, under a project of the British Iron and Steel Research Association, was described by Dr. V. E. Cosslett and D. Jones. It is designed to operate up to 90 kV. with an objective of long working distance ($f = 15$ mm.) so that metallurgical specimens of convenient size can be accommodated. An intermediate diffraction lens is included, and the dimensions of the imaging system are calculated to eliminate distortion and chromatic defects from the diffraction image[5]. The illuminating angle can be mechanically varied from 0° up to 10°, and inclination and translation of the specimen is possible. A large object-chamber is provided so that experiments can be carried out at high temperature or during chemical or mechanical action on the surface of the specimen. Reflexion micrographs of typical metallurgical structures show a resolution of 600–700 A.; an objective of smaller chromatic error is being designed. Comparison with optical photographs assists in interpreting the foreshortened pictures, but it may be preferable to leave them in this state, where the relief is immediately obvious, rather than to correct them to the condition of vertical viewing.

The effect of the electron beam on the specimen must be considered in reflexion as in transmission, though it appears that the danger of artefacts is not here so serious. The temperature rise is not so great, owing to the large thermal capacity and good conductivity of the specimen, but might be serious in non-conductors; the latter can be made sufficiently conducting to avoid charge accumulation by depositing a thin layer of metal on them. But even with metals a slow etching process occurs, either by direct ejection of metal ('electronic sputtering') or by temperature rise sufficient to give thermal etching. Cosslett and Jones showed that the appearance of a ruled grating changed considerably after long exposure (~ 1 hr.) to the electron beam (Fig. 3).

On the other hand, a carbonaceous layer is produced on the irradiated part of the specimen unless the surface temperature is high, but not rapidly enough to obscure detail within the resolving power attainable. Indeed, the 'shadows' thus formed behind projections on the surface have the useful property of allowing ready identification of the irradiated region in subsequent optical examination, as well as estimation of the height of the projections, as pointed out by Dr. J. W. Menter (Physics and Chemistry of Surfaces Laboratory, Cambridge). He described the experience gained with a reflexion head of fixed inclination fitted to an *EM*3 instrument, and also discussed the attainable resolution and the interpretation of reflexion micrographs. A variety of metallic and crystalline surfaces have been examined with an aperture of 3×10^{-3} and a resolution approaching 400 A.[6]. In this way, cleavage steps on mica and growth spirals on silicon carbide have been observed. Slip lines on cadmium show well, if orientated across the line of view, and a cleavage surface of zinc gave particularly striking results (Fig. 4). Very slight inclinations of the surface (~ 4°) across a twin are clearly visible; the black lines across the field of view are cleavage steps. Menter indicated also some possible applications to the study of the surface of biological objects.

A short account of the work in the U.S.S.R. on reflexion microscopy[4] was given in another session of the conference; it follows very closely the developments described here. A rather different system due to Möllenstedt (A.E.G.–Zeiss) was briefly described by Prof. O. Scherzer (Technische Hochschule, Darmstadt). It employs an ion beam, incident

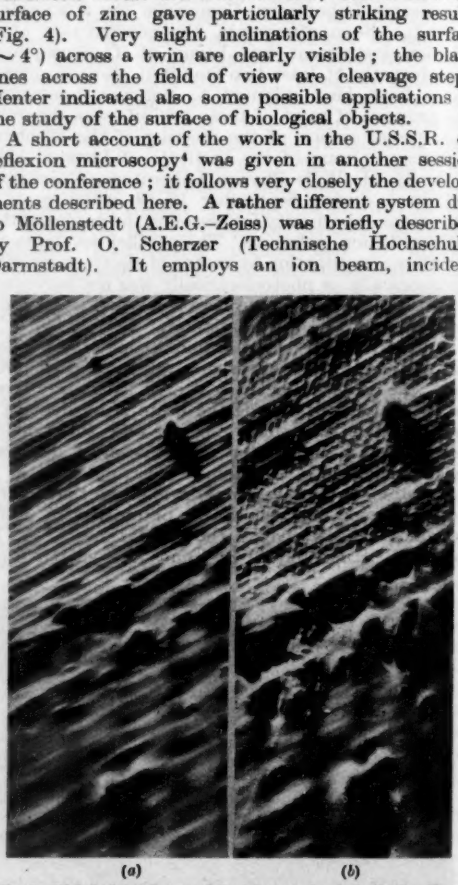


Fig. 3. Nickel-plated brass ruled at 5-μ spacing in both directions in upper part of field, but in only one direction in lower part: (*a*) when first exposed to electron beam, $\theta_1 = 2\frac{1}{2}°$ and $\theta_2 = 7\frac{1}{2}°$; (*b*) after exposure of about 1 hr. in beam, $\theta_1 = 1\frac{1}{4}°$ and $\theta_2 = 8\frac{1}{2}°$. Transverse magnification × 1,600. (Cavendish Laboratory, Cambridge)

at 45° on the specimen surface, to excite emission of electrons, which are then collected by an electrostatic lens at a voltage of 30 kV. Micrographs at a resolution of about 1000 A. have already been obtained. The chief advantages are that the surface is viewed normally so that no distortion occurs, and that the voltage spread of the emitted electrons is only about 3 V., so that chromatic aberration is negligible.

In the usual type of electron microscope a macroscopic area of specimen is illuminated, and the whole of the image is projected at once. D. MacMullan (Engineering Laboratory, Cambridge) described a scanning microscope, in which a fine electron beam is caused to explore the object point by point, the transmitted (or reflected) intensity being collected in an electron multiplier the output of which modulates the intensity of the synchronously deflected spot of a display tube. As there are no lenses beyond the object, the energy loss of the scattered beam leads to no chromatic aberration, and the resolution is limited only by the size of the exploring probe. In principle this can be reduced to the order of Angstrom units by high demagnification of the primary beam, but the intensity becomes impracticably small because of lens aberrations. So far a spot size of some 500 A. has been obtained with a beam current of 5×10^{-12} amp., giving images of this resolution both in transmission and by reflexion. The new instrument is a great advance in both resolution and speed of operation on earlier attempts to use the scanning principle[7]. It promises better ultimate results than the simple reflexion method, both in resolution and in lack of damage to the specimen. As a much greater proportion of the scattered beam is utilized and object points are illuminated successively, not simultaneously, the rate of energy transfer is very low. On the other hand, the reflexion method can be practised by a simple adaptation to an existing microscope, with no extra electrical complications. Both methods open up new prospects of high-resolution microscopy, especially for metallurgy, and the full exploration of their potentialities will be awaited with great interest. V. E. COSSLETT

[1] Ruska, E., and Müller, H. O., *Z. Phys.*, **116**, 360 (1940).
[2] von Borries, B., *Z. Phys.*, **116**, 370 (1940).
[3] von Borries, B., "Die Uebermikroskopie", 200 and 312 (Berlin, 1949).
[4] Sushkin, N. G., *et al.*, *Bull. Acad. Sci. U.S.S.R.*, **15**, 285 (1951). Kushnir, U. M., Biberman, L. M., and Levkin, N. P., *ibid.*, 306 (1951).
[5] Cosslett, V. E., and Jones, D., Rep. Int. Cong. Electron Micr., Paris (1950).
[6] Menter, J. W., *J. Inst. Metals* (in the press).
[7] Zworykin, V. K., Hillier, J., and Snyder, R. L., *Bull. Amer. Soc. Test. Mater.*, **117**, 15 (1942). von Ardenne, M., *Z. tech. Phys.*, **19**, 407 (1938).

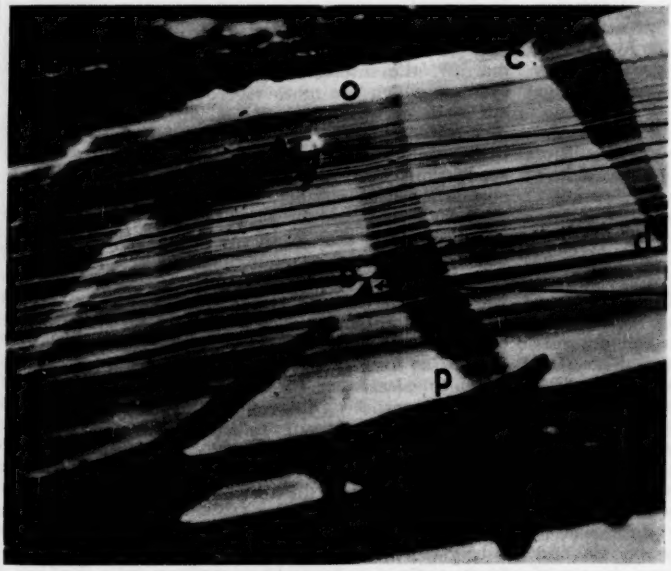


Fig. 4. Cleavage surface of zinc single crystal, showing twins (*cd*, *ef*, *op*) and dust particles (*a*, *b*); $\theta_2 = 5°$. Transverse magnification × 1,800. (Physics and Chemistry of Surfaces Laboratory, Cambridge)

CYTOCHEMICAL AND CYTOLOGICAL STUDIES OF DRUG ACTION*

By PROF. J. F. DANIELLI
King's College, London, W.C.2

THE majority of the actions of drugs are exercised at the cellular or lower levels of organization of living matter. As our knowledge of cell physiology is extremely limited, so likewise must our knowledge of drug action be limited. But the present rapid expansion of our knowledge of cellular activities ensures that each year new possibilities become available to the student of drug action. In this article some recent cytological and cytochemical studies of drug action will be briefly discussed.

The mitotic poisons have particularly attracted the attention of cytologists. These substances are of interest from many points of view—in the analysis of nuclear behaviour, for the production of mutant and polyploid strains, for the chemotherapy of tumours, etc. Only in the past few years has it been sufficiently realized that mitosis is not a unitary process, but consists of a considerable number of phenomena which normally, but not necessarily, occur in succession. Among the processes involved or essential for mitosis are duplication of genes and of chromosomes (involving syntheses of specific nucleic acids and proteins), the disappearance and reappearance of nucleoli, spiralization and despiralization of chromosomes, division of the centrosome, breakdown of the nuclear membrane and its reformation, formation and disappearance of the spindle and asters, formation of the equatorial plate of chromosomes and the separation of daughter chromosomes: all this is normally succeeded by cytoplasmic division, which is in itself a separate and complicated group of phenomena. Careful studies by cytologists have shown that substances which interfere with

* Based on a public lecture delivered at University College, London, on February 22.

nuclear division may act upon almost all, if not quite all, the individual features of division, with a highly variable degree of specificity. At one extreme, Ostergren[1] and his colleagues have shown that almost any organic substance, if present in a concentration of the order of one-fifth to one-tenth of the level required to exercise a non-specific narcosis, will interfere with mitosis by causing (for example) chromosomes to adhere to one another to an abnormal extent. This is a quite non-specific action. At the other extreme, substances such as colchicine, podophyllotoxin and aminopterin will interfere with some mitotic phenomena at a concentration greatly below the narcotic level[2]. This can be a very specific action, exercised mainly on one or a few of the phases of mitosis. Between these two extremes lie substances which show some degree of specific action. Cytochemical studies so far have indicated only that, when a given cytological abnormality is produced, it has a characteristic cytochemistry, irrespective of the agency which produced the abnormality.

Many attempts have been made to produce a theory of action of mitotic poisons, for example, that they react with SH groups of proteins, or involve cross-linking of protein or nucleic acid molecules by bifunctional compounds. But no theory has so far been proposed which has commanded any considerable measure of support. It seems improbable that all mitotic poisons work by the same mechanism, and experience in other fields suggests that different groups of mitotic poisons have different initial modes of reaction with cells, and that the resemblances that are seen in the effect of these substances result from a funnelling process. It is common experience in cell physiology to find that if a cell is capable of a given activity, then many unrelated agents will elicit this activity, that is, cells appear to be organized so that a diversity of agents will produce a limited number of responses[3]. In the case of mitotic abnormalities, not only are similar abnormalities produced by X-rays and by many different families of chemical substances, but also by malnutrition and even by simple exposure to hypotonic or hypertonic media. Thus mitotic abnormalities are produced by a wide variety of unrelated agents which produce their end-effects on a complicated sequence of processes.

This phenomenon of the 'funnelling in' of the action of agents to give similar mitotic abnormalities makes it appear probable that we shall only achieve understanding of the mode of action of mitotic poisons by the highly detailed investigation of individual groups of closely related substances. The beginning of such an analysis, on the cytological level, has been made by a number of workers, particularly Ford[4], Revell[5] and Koller[6]. Their work has shown that in the case of the Walker rat tumour and of bean root tips the sensitivity of a cell depends upon its position in the mitotic cycle. Thus the number of chromosome breaks in bean root tips which is produced by a given dosage of X-rays is minimal just after mitosis, reaching a maximum if irradiation occurs shortly before mitosis. But with a nitrogen mustard, and also with a diepoxide, exactly the reverse condition was found: sensitivity was greatest immediately after mitosis, reaching a minimum just before mitosis. This difference is emphasized by the fact that, whereas anoxia and presence of SH compounds affords some degree of protection against the action of X-rays, no such protection occurs against the action of a nitrogen mustard. It thus seems certain that, although X-rays and these two chemical substances produce similar mitotic abnormalities, their modes of action must be quite different. Furthermore, colchicine and aminopterin will produce a maximal effect if applied just before mitosis: consequently these two substances must produce spindle abnormalities by a process quite different from that involved in the action of a nitrogen mustard[3].

A more intimate knowledge of the mode of action of some mitotic poisons might be obtained by cytochemical methods. In principle the site of action of, for example, a nitrogen mustard, could be determined either by auto-radiography of a mustard containing a radioisotope, or by the development of a colour reaction for a mustard[7]. So far no results have been recorded of auto-radiographic studies. But attempts have been made by Bell and Danielli to determine the site of action of an aromatic nitrogen mustard synthesized by Ross. It was found that there was no evidence of specific attack of the mustard on any particular cell site: the action is diffuse. This conclusion is supported by the results of Ord and Danielli using the technique of nuclear transfer. By this technique it was shown that an exposure to a nitrogen mustard which is just lethal to cytoplasm is also just lethal to the nucleus. There was no sharp selectivity of the nitrogen mustard for either nucleus or cytoplasm.

Although the detailed investigation of the cytological and cytochemical effects has not revealed the mode of action of any one mitotic poison, nevertheless the work of Koller and others has profoundly influenced our attitude towards these substances as chemotherapeutic agents. For it has been shown that, although almost all the compounds which have a value as chemotherapeutic agents for tumours cause chromosome breaks and mutations, nevertheless it is improbable that these beneficial effects are due to chromosome breaks, etc. What then is the significance of this correlation of therapeutic action with ability to cause chromosome breakage and mutation? Perhaps the answer is to be found in the fact that the tissues which are most sensitive to mitotic poisons include tumours, lymphocytes, the bone marrow, the intestinal epithelium; that is, those systems which are most vigorously engaged in the synthesis of proteins and nucleic acids. The production of chromosome breaks and mutations may be viewed as an interference with the synthesis of specific proteins and nucleic acids; and so the correlation between therapeutic effect and ability to produce chromosome breaks and mutations may simply indicate that in all cases the agent is acting, directly or indirectly, upon the systems synthesizing specific proteins and nucleic acids. If this is so, there will be great difficulty in finding a mitotic poison which is more effective as a therapeutic agent than those which are already known. The reason for this is that, so long as the agent which is sought is one which is selective in its action upon nucleic acid or protein synthesis, the agent must be no more destructive to tumour cells than to those vital systems of the body which are also normally engaged in the rapid synthesis of proteins and nucleic acids. To escape from this dilemma a new approach to this type of drug is essential.

A possibility which appears promising is to design a drug which, while still a mitotic poison, is dependent for its action upon another cell variable, that is, the requirement for whose action is based not on one but on two cell variables. The larger the number

of cell variables concerned in determining a drug action, the more selective will that drug be. Two additional variables which will be considered here are (i) enzymic constitution, and (ii) secretory activity.

Greenstein has pointed out that each cellular species, including tumour cells, displays a characteristic spectrum of enzymic activities[8]. There are enormous variations in the concentrations of particular enzymes in particular cell species. If, therefore, we take a mitotic poison, and inactivate it by adding to it another group, we make that substance relatively inert except to those cells which have a high concentration of the enzyme which can remove the inactivating group. In fact, we endow the mitotic poison with the equivalent of a proximity fuse, which is touched off only by a particular enzyme[3]. Instead of having a mitotic poison which is specific only for cells which are rapidly synthesizing nucleic acids and proteins, we should have a poison which should act only on those cells which are rapidly synthesizing proteins and nucleic acids, *and* which also contain a high concentration of a particular enzyme.

Designing a drug to fit into certain cellular secretory patterns also holds some promise. It is known that cells may be extremely selective in the types of molecules which are concentrated within their plasma membranes. But detailed information is much more scanty than is the case for the distribution of enzymes, and consequently the exploitation of this variable is likely to be less rewarding at the present time.

It is perhaps important to point out that these two variables have been exploited in the past—inadvertently. The reason why neoarsphenamine is an effective drug for treatment of certain infections of the central nervous system is that (*a*) as a result of having a particular type of distribution of polar groups, it is caught up by the secretory cells of the blood–brain barrier and transferred from the blood into the brain, and (*b*) once in the brain it is reduced to liberate active arsenoxides from a hitherto inactive compound.

Another stimulating example of the use of cytochemical techniques is the work recently carried out at King's College by P. H. Staple[9] on the use of diphenylhydantoin. This drug is in common use for the treatment of epileptics. It acts as an anticonvulsant, without causing widespread depression of the central nervous system. But in a proportion of patients the drug causes gingival hypertrophy, which interferes with eating and is unsightly. Cytochemical studies of the hypertrophied tissue showed that connective tissue, particularly collagen, was involved. Collagen is known to be influenced by corticosteroids, and the peculiar localization of the hypertrophy and the waywardness of its incidence were suggestive of a 'stress' abnormality involving the adrenals. Consequently the adrenals of mice were examined by cytochemical methods after a period of treatment by the hydantoin. A gross lesion of the adrenals was revealed. On the hypothesis that the drug was acting directly on the adrenals, it was argued that aspirin might antagonize the undesirable side-reactions of the drug. But it was speedily found that administration of aspirin antagonizes the central effects of the drug, and precipitates convulsions.

It thus became necessary to consider the possibility that both the central and peripheral effects of diphenylhydantoin are mediated through the adrenals, that is, that epilepsy might be caused by either (*a*) excessive secretion of cortisone, or (*b*) abnormal sensitivity of some part of the central nervous system to cortisone. Either possibility might involve a breakdown in glucose supply to part of the brain tissues. In confirmation of this line of thought, evidence has been found that cortisone and adrenocorticotropic hormone may induce epileptic convulsions in a proportion of normal patients, whereas deoxycorticosterone, which in some respects is antagonistic to cortisone, will protect epileptics against convulsions.

It is evident that, with the aid of cytological and cytochemical techniques, entirely new ground can be broken in the study of drug action and in the development of new drugs.

[1] Ostergren, *Hereditas*, **29**, 429 (1943). Ostergren and Levan, *Hereditas*, **30**, 496 (1944).
[2] Hughes, "The Mitotic Cycle" (Butterworth, London, 1952).
[3] Danielli, "Pharmacology and Cell Physiology" (Elsevier, Amsterdam, 1950).
[4] Ford, *Hereditas* Supplement, 570–571 (1949).
[5] Revell, British Empire Cancer Campaign Report, **28** (1951).
[6] Koller, British Empire Cancer Campaign Report, **28** (1951).
[7] Danielli, "Cytochemistry: a Critical Approach" (Wiley, New York, 1952).
[8] Greenstein, "Biochemistry of Cancer" (Academic Press, New York, 1947).
[9] Staple, *Lancet*, 1074 (1951); 372 (1952).

FIBRES, OLD AND NEW

THE primary needs of man have always been food, shelter and clothing. The first he was promised by the sweat of his brow; the second he found originally in caves and other natural formations until primitive constructive abilities and later engineering skills enabled him to build to his own design; but the third provided him at a very early stage in his development with scope for extraordinary ingenuity, especially in his discovery of the possibilities of fibres. The historical, scientific and economic consequences of this discovery were discussed at Belfast on September 5 by Section B (Chemistry) of the British Association, when Dr. Douglas W. Hill (British Cotton Industry Research Association) introduced the subject, Dr. A. J. Turner (Linen Industry Research Association) discussed "Naturally Occurring Fibres", Dr. A. R. Urquhart (Lansil, Ltd.) "Natural Polymer Fibres" and Dr. Rowland Hill (Imperial Chemical Industries, Ltd.) "Synthetic Polymer Fibres".

The origins of textile manufacture are lost in antiquity. Before history began, men had discovered the secret of twisting fibres together and interlacing the resultant yarns to produce strong and flexible coverings. So valuable did these products prove to be, not only for clothing but increasingly for all kinds of coverings and later for industrial purposes, that the world was combed for raw materials for the textile industry. Animal, vegetable and mineral products, provided they possessed the requisite fibre form, were all pressed into service, and new uses and new manufacturing methods were constantly exploited. The animal world yielded wool, horsehair, mohair and alpaca, the hair of cows, camels and the fur of rabbits, in addition to silk, both cultivated and wild. From the vegetable world came cotton, linen and flax, ramie, jute and coir, hemp, manila, sisal and phormium, and many others as major articles of commerce, as well as locally-used fibres such as those from the pineapple, from which yarns and fabrics of the finest quality have been produced.

Even paper, cut into narrow strips and twisted, has been extensively used. The mineral world yielded asbestos, the only natural fibrous mineral, and also gold, silver, copper, iron and glass, all of which can be converted to fibrous form for use in the spinning and weaving processes. The vast number of industrial commercial natural fibres now in use has been established by a struggle for survival in world markets, but the search for new ones continues vigorously.

The larger proportion of the world's textiles until quite recently was a matter of agriculture. In view of the stress which was rightly laid during the meeting on the importance of research in the production and use of the natural and synthetic polymer fibres, it is perhaps as well to appreciate that, but for research work, there would be only a minute production of the natural fibres. In fact, while it is generally realized that the man-made fibres are a consequence of man's control of physical forces, it should not be overlooked that the present abundance of natural fibres is no less dependent on man's control of biological forces. The original wild, naturally occurring fibres were mostly deficient in the qualities that would make them economically valuable to-day, and they have been improved out of all recognition by selection and breeding. Research continues to-day in greater measure than ever to produce new varieties and strains with improved yield and quality and disease resistance, while extensive agronomic experiments are directed towards improving cultivations.

It might be thought, in the light of the available natural fibres, with all their different chemical and physical characteristics, that the need for and the opportunity of successfully launching man-made counterparts would be negligible. In a world hungry for textiles, however, every possibility of increasing the total supply or widening the range of properties has been avidly seized upon. The suggestion that fibres might be produced artificially is by no means a new one. In 1664 Dr. Robert Hooke put forward the idea that suitable substances could be drawn out to produce fibres, and in 1841 a machine for spinning artificial fibres was actually demonstrated at the British Association's meeting in Manchester. Although this project came to nothing, it is significant in that it was the forerunner of the spinneret afterwards used so effectively in the rayon industry, and that the filaments demonstrated at that meeting were drawn glass, which has become one of the latest additions to the range of commercial textile fibres. The further development of artificial fibres was stimulated not by the textile industry but by the demand for filaments for use in the new electric-light bulbs. Sir Joseph Swan took out a patent in 1883 for fibres drawn from nitrocellulose which was afterwards denitrated, and these were exhibited in 1885 in their first textile form as crocheted nets. The Count de Chardonnet had also patented textile fibres drawn from nitrocellulose in the previous year, but unfortunately he did not denitrate his fibres, and the dangers which he introduced were so great that the use of his products was forbidden.

The rayon industry, as we now understand it, may be said to have started in 1891 with the discovery by Cross and Bevan that cellulose could be dissolved in a mixture of caustic soda and carbon disulphide to produce viscous solutions from which the cellulose could be readily regenerated after drawing out into fibres. From the success of the first regenerated fibre have sprung many others, including cuprammonium rayon, obtained by extruding a solution of cellulose in cuprammonium hydroxide into water; cellulose acetate after the First World War; and in more recent times, 'Ardil' from groundnut protein, alginate fibre from seaweed, 'Vicara' from zein and 'Lanital' from casein. Once again, as in the case of the natural fibres, a great hunt for spinnable materials took place, and every conceivable waste-product was tested for its possibilities for this purpose. Egg-white, feathers, silk waste, soya bean and fish have all been used to provide further weapons in the armoury of the regenerated fibres.

Two facts stand out with peculiar significance in this narrative. The first, and more obvious, is that the advances in fibre production have occurred during the past fifty years. Though the methods of manufacture changed and were continually refined, the same basic materials were used by the milliners in the fashion houses of Paris at the beginning of the twentieth century as had been used thousands of years earlier by the dressmakers in the courts of the Pharaohs.

The second and less obvious fact is that, although the advent of man-made fibres coincides with the development of scientific research, viscose rayon was a discovery of an empirical nature. It could, indeed, scarcely have been anything else, since there was at that time no understanding of the nature of fibre structure. The classical methods of organic chemistry which proved so fruitful in other directions were virtually ineffective when applied to fibres. The properties of fibres to which they owe their value for textile purposes are mechanical ones, such as strength and elasticity, and the chemists of the nineteenth century, though interested in some physical properties of materials, had not regarded mechanical properties as coming within their purview.

At the time when the production of viscose rayon was a fully developed industry, the modern theory of the structure of textile fibres was unborn. Even at the time of the development of acetate rayon, the conception of the cellulose molecule as a very large number of glucose units combined with one another by glucoside-like linkages to form a long thin chain was neither widely known nor generally accepted.

The study of synthetic linear polymers, of which the constitutions were known, provided the key to the problem of fibre structure. It introduced the conception of average molecular weight in place of the previously accepted constant molecular weight, together with relationships between viscosity and average chain-length which were independent of chemical transformations.

One well-known phenomenon proved to be a considerable obstacle to the acceptance of the molecular chain theory, for, if cellulose consists only of identical glucose units identically linked, there appears to be no reason for supposing that the conditions which produced rupture of some bonds would not produce rupture of all of them. It was, however, well known that the hydrolytic action of dilute acids on cellulose ceased before complete conversion of the molecule to glucose units. Fortunately the application of X-ray studies to the problem of fibre structure provided a solution. These studies established the presence in the fibre of crystallites interspersed with amorphous regions. In the light of this evidence, the action of dilute acids on cellulose became less a matter of chemical reactivity and more a matter of accessi-

bility, the amorphous, loosely packed, randomly arranged areas being more accessible to the acid than the highly oriented, densely packed crystallites.

The X-ray studies also offered an explanation of the strength of textile fibres and opened up a method of increasing it and of changing the chemical reactivity. According to the modern view the strength of a fibre is determined not by the strength of the glucoside link but by the secondary valencies or hydrogen bonds holding the crystals in a regular pattern; and it breaks, not by rupture of the primary valencies, but by the chains slipping past each other, with a consequent rupture of the hydrogen bonds holding the structure together. The greater the length of the chains, therefore, the longer the overlaps between them and the greater the number of lateral bonds which must be disrupted before breakage occurs. The extent of the crystallinity, it was soon learned, could be increased by mechanical means, particularly stretching, which brought about, as X-ray studies showed, a further orientation of the fibrous molecules.

The climax of the study of fibre structure was reached in the decade following 1928. In that year a long-range fundamental study was initiated in the Du Pont laboratories under the brilliant direction of Dr. W. H. Carothers, which produced in 1931 the announcement of what amounts to a specification for the production of fibres from synthetic polymers. The specification still holds, though it can now be filled in with greater detail. The proof of Carothers's views was provided by the publication in 1938 of the patents covering the production of nylon—polyhexamethylene adipamide—not only the first of the synthetic fibres but also the first fruit of the modern theory of fibre structure.

The pattern of development of both the natural and the regenerated fibres was again followed. A vast search began for synthetic polymers which could be converted to commercially valuable fibres. Nylon, therefore, has been succeeded by others, including 'Perlon', another polyamide, 'Orlon' and 'Acrilan', polyacrylic fibres, 'Vinyon', a co-polymer of vinyl chloride and acrylonitrille, 'Saran', a co-polymer of vinyl and vinylidene chlorides, and 'Terylene', polyethylene-terephthalate.

The discovery of how to use the fibres provided by Nature, by twisting them into yarns and producing from them delicate and serviceable fabrics, must rank as one of the greatest and most lasting achievements of human genius. The unravelling of the inner secrets of their structure is a further chapter in this story, no less enthralling than the earlier episodes, and proving, if proof were needed, that man has sustained his genius through the centuries.

The introduction of synthetic fibres has not meant, so far, that the older fibres have become obsolete. The rayon industry has grown from a production of 2 million lb. a year in 1900 to more than 3,500 million lb. a year in 1950. Synthetic fibres have increased from 2 million lb. a year in 1938 to 150 million lb. a year in 1950. Both are still expanding industries; both offer competition to the natural fibres; yet the use of cotton and wool has also expanded during the century, and even silk, which had a production of 38 million lb. a year in 1900, still reached a production of 36 million lb. a year in 1950, after all the vicissitudes, devastation and trade dislocation consequent upon the Second World War. The present world production of textile fibres is about 22,000 million lb. a year, and during the past decade it has shown an annual increase of about 3 per cent; of this total, the man-made fibres contribute about 15 per cent. The struggle for survival which established the commercially valuable natural fibres will ultimately decide the relative use of the natural, regenerated and synthetic fibres.

It is improbable, however, to say the least, that an ideal fibre suitable for all purposes will ever be discovered. Consider for a moment the many demands which may be made upon fibres. Apart from the fact that they must be available in very large amounts, they may be expected to exhibit strength, elasticity, resistance to abrasion, resistance to shrinkage, to soiling, to fire and to light, moisture absorbency or moisture repellence, warmth, affinity for dyestuffs, chemical reactivity or chemical inertness, and many other properties, some of them all at the same time, and some of them mutually opposing.

Moreover, progressive industrialization demands specialization in fibres as it has already done in metals and other materials. It is true that modern theory has taught us how to modify fibres to meet more exactly the demands made upon them. Rayon, for example, introduced as an apparel fibre, now finds a great outlet in tyre yarns; and nylon, renowned the world over as America's contribution to lustrous hosiery, has gone to war in parachutes, glider tow-ropes and now in bullet-proof vests. Nevertheless, there is a natural limitation to what can be accomplished with any single fibre. It is instead the variety of properties available in different fibres, either alone or in admixture with each other, which makes it possible for designers to fulfil almost any demand that they may be called upon to meet. So varied are these demands that virtually any outstanding property can be turned to advantage, whether it be the buoyancy of kapok, the drape of acetate rayon, the utility of cotton, the warmth of wool, the glamour of silk, the strength of nylon, the fire-resistance of glass or even the solubility of alginate.

On the other hand, the production of the different classes of fibres may well be governed by considerations other than their immediate apparent usefulness. Of the primary needs of man referred to at the beginning of this article, it must be accepted that food is pre-eminent, and an expanding world population, much of which is already below a reasonable subsistence-level, will call for a concerted attack on the problem of food supplies. The natural fibres are all produced in the temperate and warm regions of the world, that is, in just those regions which must be relied upon for any increase in the production of food. Regenerated protein fibres too, though now manufactured from materials unfit for consumption as food, might find that a general food shortage enforced improvements in production methods of their raw materials which would make them suitable foodstuffs for human or animal consumption. The regenerated cellulose and acetate rayons and the synthetic fibres might in such circumstances make a considerable contribution to the food situation. The manufacture of the cellulose and acetate rayons from wood pulp enables a new area to be utilized for fibre production, namely, the Arctic and sub-Arctic forest regions, in which there is no competition with food production. It might be, therefore, that the future will see a reduction in the quantity of natural fibres used, and their replacement by fibres derived from wood pulp.

The future of the synthetic fibres may be limited chiefly perhaps by the availability of raw materials and the vast investment costs of the necessary plant. How great are these costs is not generally appreciated. It is reported that, for the development of nylon, the Du Pont Company spent 45 million dollars on research, 21 million dollars on sales campaigns and 196 million dollars on plant. The new plant of Imperial Chemical Industries, Ltd., for the production of 'Terylene' is estimated to cost £10 million. It is not surprising, therefore, that the birth of a structurally new fibre of merit and distinction is a rare occurrence. The combined efforts of the great many scientific workers who during the past twenty-five years have examined thousands of possible products have led only to five classes of synthetic fibres.

Nevertheless, whatever the future relations may be between the various classes of fibres, textile manufacturers now have at their command a range from which it is possible to create products transcending all past conceptions of textile utility. In the near future, the art or, as it is now fast becoming, the science of textile production may reflect as never before our achievements in the fields of chemistry and physics.

D. W. Hill

ANTIBIOTICS IN ANIMAL NUTRITION

Within the past decade the application of antibiotics has had a profound influence on human and veterinary medicine. Recent developments show that their impact on agriculture may be equally important, and it was apposite that this year at Belfast, Sections I (Physiology) and M (Agriculture) of the British Association should discuss in joint session the place of antibiotics in animal nutrition.

In his opening remarks, Dr. S. K. Kon (National Institute for Research in Dairying) traced the steps that led to the surprising discovery of the growth-promoting effects of these drugs. It has been known for a long time that proteins of animal origin are, on the whole, biologically superior to those derived from plants; in fact, the classic concept of first- and second-class protein was based on this distinction. When later the emphasis shifted from protein as such to its component amino-acids, it became evident that something else apart from a good balance of these was responsible for the special virtue of animal sources of protein. Work with rats and poultry in the United States, especially by Hartman and Cary and Bird and his associates at Beltsville and the Zuckers of Columbia University, showed that these products carry a hitherto unrecognized growth substance which, owing to its association, came to be known as the animal protein factor. It is only fair to recall that some twenty years ago Dr. Katherine Coward, working in England in the laboratories of the Pharmaceutical Society, showed that the purification of casein deprived it of something essential for the proper development of rats on synthetic diets.

With the brilliant isolation in 1948 of the anti-pernicious anæmia factor by Rickes and his associates, of the Merck Laboratories, New York, and by Lester Smith and colleagues, at the Glaxo Laboratories, Ltd., Greenford, and its identification as a vitamin by the former workers, it soon became apparent that vitamin B_{12}, as it was called, accounted for much of the special activity of carriers of the animal protein factor. The value of vitamin B_{12} in enhancing practical rations for pigs and poultry in the United States led to a search for suitable sources, and these were found in the residues from the antibiotics industry, especially from fermentation processes in the preparation of aureomycin and streptomycin. Thus a substance at first believed to ennoble only animal tissues came to be derived mainly from activities of micro-organisms.

The crude product from *Streptomyces aureofaciens* proved better in poultry rations than an equivalent quantity of pure vitamin B_{12}. Shortly after this observation, Stokstad and Jukes, of Lederle Laboratories, announced that the superiority was due to the presence in the residue of traces of aureomycin and that the antibiotic, even by itself, promoted the growth of pigs and poultry. At first sight this unexpected effect seemed scarcely credible, and Dr. Kon confessed his initial disbelief; but confirmatory evidence soon came from numerous laboratories in the United States and from the Shinfield Dairy Institute itself, establishing that animals benefit from the addition to their diet of any one of several antibiotics, especially penicillin, aureomycin, terramycin and streptomycin. Commercial application on a large scale was not slow to follow in the United States, where antibiotics are now included in many practical rations for pigs, chicks and turkeys.

In Great Britain the use of antibiotics is governed by the Penicillin Act, 1947, and their addition to rations is for the time being prohibited. Controlled experiments are now in progress in several centres under the ægis of the Agricultural Research Council, and an official statement of policy will no doubt be made when the tests are completed. This cautious attitude is certainly well founded. To begin with, husbandry and feeds in Britain are so different from those in the United States that British workers cannot call on the wealth of American experience but must work out their own solution. In examining the problem afresh, the possible dangers of placing powerful drugs indiscriminately in the hands of farmers must be carefully considered. Their action on frank disease must be dissociated from that in promoting growth of apparently healthy stock. How the antibiotics act is still a mystery, though all indications are that it is in some way through the gut flora. Long-term effects, with the associated risk of appearance of resistant strains, must thus be faced. Finally, the value of antibiotics for ruminants and for laying birds is, to say the least, doubtful, and care must be taken that they reach only those animals they can help. Antibiotics may well become of major importance in British agriculture, but they should not be introduced without proper safeguards.

Dr. M. E. Coates (National Institute for Research in Dairying) discussed the mode of action of antibiotics. Three hypotheses to account for the growth-stimulating properties of antibiotics, when given by mouth, have been proposed: they may themselves be essential growth factors; they may alter the intestinal micro-organisms to the benefit of the host; or they may suppress some infection in the gut interfering with normal growth.

The first explanation is unlikely, since several antibiotics of different chemical constitution all have a similar growth effect; in addition, this effect is shared, though to a less extent, by sulphonamides, arsonic acids and some detergents and is, therefore,

more likely to be brought about through the common antibacterial action of all these compounds.

The remaining two hypotheses were investigated in experiments, which Dr. Coates proceeded to describe. Repetition at Shinfield confirmed the original findings of Stokstad and Jukes that pure aureomycin promotes the growth of chicks, and penicillin and terramycin acted similarly. The antibiotics were effective with normal chicks and with chicks deprived of the animal protein factor. Most of the later work was done with only one antibiotic, penicillin, which was readily available in Great Britain. Assays showed that, given as the procain salt to the extent of 25 mgm./100 gm. diet, it survives in bacteriostatic concentrations as far as the lower intestine, but no consistent bacteriological differences were detected either by direct microscopy or by cultural methods between birds with or without the antibiotic.

Changes in microbial population or in its behaviour are likely to result in changes in vitamin requirements of the host chick, particularly of those vitamins of the B complex that can be synthesized by intestinal micro-organisms. Experiments with diets deficient in any one vitamin indicated that penicillin increases the chick's requirement for nicotinic acid but spares biotin, folic acid and one or more unidentified components of the complex represented in the animal protein factor. Biely, in Vancouver, found that aureomycin spares nicotinic acid, folic acid and riboflavin, but the differences between the two laboratories were probably due to differences in experimental conditions. The salient point was that these vitamin economies alone are insufficient to account for the dramatic growth response to antibiotics, particularly as it was also obtained at Shinfield with baby-chick mashes containing ample vitamins and animal protein. Comparison of these latter findings with those of workers at the Glaxo Laboratories provided a pointer to a different explanation in that chicks at Glaxo given baby-chick mashes did not respond to penicillin. The chick rooms at Shinfield had been in continuous use for poultry for at least ten years, whereas poultry had rarely been housed in the Glaxo Laboratory. In a joint experiment chicks from the same hatch and receiving the same batch of diet were divided between the old Shinfield place, a new room there that had never contained poultry, and the Glaxo Laboratories. Penicillin improved growth only in the old place. The treated chicks grew as well there as those, treated or untreated, in the other two places where penicillin had no effect. The antibiotic was, in fact, preventing a depression, rather than causing an increase in growth. Chicks from the new room showed a similar depression when birds from the old room were placed in the same cages with them. Careful examination of the birds revealed no signs of any recognizable disease, and the evidence suggested that the improved growth with penicillin in the old room resulted from a suppression of an inapparent transmissible 'infectious' condition that prevented the birds from growing optimally. Support for this view came from the work of Reyniers, of Notre Dame University, who, Dr. Coates said, obtained no response to antibiotics in his germ-free chicks.

The characteristics of the infective agent are now being studied at Shinfield by means of 'Perspex' isolation boxes, each housing two cages, in which 'infected' and 'uninfected' chicks are kept side by side. The agent can be transmitted by the whole-gut contents of 'infected' chicks, but not by those of 'uninfected'.

Dr. Coates concluded by saying that in frank disease, and in the inapparent 'infection', the beneficial effect of antibiotics on growth manifested itself both on complete diets containing sources of animal protein and on all-vegetable diets. With 'uninfected' chicks it was obvious only with the latter. Finally, with germ-free chicks, antibiotics should be ineffective whatever the diet.

Dr. W. F. J. Cuthbertson (Glaxo Laboratories, Ltd.) spoke next, on antibiotics and the animal protein factor. After outlining the steps that had led to the recognition of the animal protein factor as a complex of which vitamin B_{12} forms only one of the important constituents, he pointed out that antibiotics behave like animal foods in that they increase the growth of chicks, rats, pigs and turkeys on purely vegetable rations to a greater extent than vitamin B_{12} alone. The joint experiments with the Shinfield workers have shown that, when the growth effect is manifested with good diets containing the animal protein factor, it is due to the presence of a growth-depressant 'infection'. He has found, however, that on all-vegetable rations even 'uninfected' chicks benefited from the addition of antibiotics to their diet; the removal of the 'infection' cannot, therefore, be a complete explanation of the growth-promoting action of these drugs. The vitamin B_{12} requirements of such birds were reduced by the antibiotics. Even when the parent flock was kept on a normal diet and their 'uninfected' chicks received a vegetable ration containing ample amounts of all the known vitamins, including vitamin B_{12}, penicillin still improved growth. This effect could not be explained by a vitamin-sparing action on the known vitamins or by anti-infective activity, but indicates that the antibiotic decreases the chick's need for some unidentified essentials. In fact, the addition of heat-dried liver to the all-vegetable diet improves it only a little; but additional penicillin has a marked effect, whereas the opposite was true with freeze-dried liver, indicating that penicillin has spared a heat-labile unidentified growth essential.

A possible explanation of these findings is that antibiotics control the activities of the gut micro-organisms by encouraging those that synthesize growth factors and removing those that destroy them. Dr. Cuthbertson said that one could further speculate that the growth-depressant 'infection' demonstrated in chicks may act by increasing destruction of growth factors in the gut. Should this prove true, the addition of these factors might increase growth on rations now considered optimal but, in fact, not containing enough of certain components to allow for loss through bacterial activity.

In the discussion Mr. K. L. Robinson (Queen's University, Belfast) said that in his experiments on pigs he had obtained a marked response to antibiotics both with all-vegetable diets and with diets containing fish meal. Food utilization was also increased. Removal of the antibiotics at the mid-fattening stage produced a setback that was cured when the antibiotic was given again. Another speaker, from Dublin, said that in his experience penicillin improved the growth of pigs on diets containing maize, soya-bean meal and fish meal, but that the effect was greater when maize was replaced by wheat offals and oats. With chicks he observed improvement on all diets.

NEWS and VIEWS

Royal Society: Award of Royal Medals

H.M. the Queen has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows: to Sir Frederic Bartlett, for his creation of an experimental school of psychology which has established under his leadership an outstanding position recognized internationally as without superior; to Prof. C. K. Ingold, for his extensive theoretical and practical studies of the mechanism of, and the factors influencing, organic chemical reactions; and for his analysis of the structure of benzene.

Institution of Civil Engineers: Awards for 1951–52

The Institution of Civil Engineers has announced the following awards for papers (subjects given in brackets) which were read at meetings of the Engineering Divisions of the Institution during the session 1951–52: *Telford Gold Medal*, Dr. Carlo Semenza (the most recent dams by the Società Adriatica di Elettricità (S.A.D.E.) in the eastern Alps); *Coopers Hill War Memorial Prize*, Dr. E. J. Hamlin (sewerage and sewage disposal in subtropical countries, with special reference to South Africa and Mauritius); *Telford Premiums*, A. A. Fulton (civil engineering aspects of hydro-electric development in Scotland), M. C. White (the design and construction of the new deep-water quays at Leith), R. H. MacDonald (relation between daily rainfall and flow of the River Shin) and J. T. Calvert and P. M. Amcotts jointly (some problems in the disposal of industrial effluents and domestic wastes); *Crampton Prize*, W. Storey Wilson and F. W. Sully jointly (the construction of the caisson forming the foundation to the circulation-water pump-house for the Uskmouth generating station); *Manby Premium*, Dr. B. G. Neal and Dr. P. S. Symonds jointly (the rapid calculation of the plastic collapse load for a framed structure).

Biology at Chelsea Polytechnic, London: Dr. B. Barnes

Dr. B. Barnes will retire from the headship of the Department of Biology at Chelsea Polytechnic at the end of 1952. He was born in 1888 and after service as a schoolmaster and in the First World War he graduated with first-class honours in botany from Birkbeck College, University of London, in 1922. He served for thirteen years as a demonstrator and lecturer at that College, taking his Ph.D. in 1928 and his D.Sc. in 1933. He became head of the Department of Biology at Chelsea Polytechnic in 1934 and has served with distinction in that capacity since that date. He served for a long period on the Council of the Linnean Society and was vice-president during 1937–38, 1942–44 and 1951–52. He also acted as deputy treasurer of the Society during 1942–45 and as botanical secretary during 1944–51. He was president of the British Mycological Society in 1934 and was editor of the *Transactions* of that Society for a long period. He served for thirteen years on the Scientific Committee of the Royal Horticultural Society. He has also played his part as recorder and secretary of Section K (Botany) of the British Association. Dr. Barnes has made many contributions to botanical research and will be particularly remembered for the encouragement which he has given to the large number of research students who have passed through his hands, many of whom have afterwards gained distinction; his sympathy with the part-time student is particularly notable. The Department of which he has been head has grown during his tenure of office; it embraces the subjects of botany, zoology, physiology and chiropody, and no greater tribute can be paid to him than to note that it will in future develop as three separate and fully-fledged departments.

Mr. C. C. Hentschel

Mr. C. C. Hentschel has been appointed to succeed Dr. B. Barnes as head of the Department of Biology; the Department will in future deal only with the subjects of botany and zoology. Mr. Hentschel, who was educated at St. Paul's School, St. Bartholomew's Medical College, Birkbeck College and King's College, London, was appointed to the staff of the Polytechnic in 1931, and has been senior lecturer in zoology for many years. He was chairman of the Preliminary Medical Board of Studies of the University of London during 1944–47 and is at present chairman of the Board of Studies in Zoology and the representative of that Board on the Faculty of Science. He is vice-president of the Linnean Society, which office he has held on two previous occasions, and is a fellow of the Zoological Society. As the part author of "Biology for Medical Students", his name is familiar to many students of biology. He has witnessed a remarkable growth in the zoological section of his department since his appointment to the Polytechnic, and in the wider capacity in which he will now act will have opportunities for furthering this development.

Dr. Mary F. Lockett

Dr. Mary F. Lockett was appointed as from September 1, 1952, to the headship of the Department of Physiology; the Department had formerly been part of the Department of Biology. Dr. Lockett was educated at Cheltenham Ladies College, the Royal Free Hospital Medical School, and Newnham College, Cambridge. She was awarded the degrees of M.B., B.S. in 1935, M.D. in 1936, and Ph.D.(Cantab.) in 1945. After holding resident hospital appointments at several hospitals in London and in Cairo she became Beit Memorial Fellow for Medical Research at Cambridge during 1941–45 and was elected to a research fellowship at Newnham College, which she held during 1945–47, when she unfortunately had to resign owing to the illness of her parents. Dr. Lockett has held posts at University College, London, and the University of Glasgow. She is an active research worker with many publications to her credit, and will have full scope for her great ability in building up her new department at Chelsea Polytechnic.

Research Grants for the Department of Anatomy, Oxford

A grant of 12,000 dollars has been made by the Rockefeller Foundation to the University of Oxford for advancing the research in technical methods of microscopy which is being carried out in the Department of Human Anatomy under the direction of Dr. R. Barer. During the past few years, these studies have been concerned with optical methods which are particularly suitable for the investigation of living cells, and the Department is fortunate in possessing (through the generosity of the Nuffield Foundation) the first new Burch reflecting microscope, an instru-

ment which is specially advantageous for ultra-violet and infra-red microspectrography. Other specialized techniques under development include various forms of phase-contrast and interference microscopy, which are now being used for a general programme concerned with the action of physical and chemical agents on living cells. Recently, new methods have been devised for the optical determination of cell mass and the regional concentration of solids within living cells. Some applications of these are likely to prove of considerable value in clinical pathology.

A grant of £1,500 a year for three years has also been made by the National Coal Board for research work to be carried out in the Department of Human Anatomy (under the direction of Dr. J. S. Weiner) in collaboration with the Medical and Rescue Personnel Departments of the Board. For some years the Medical Research Council Climatic and Working Efficiency Unit in the Department has been engaged on fundamental and applied investigations on human adaptation to climate, particularly to hot environments. It is now proposed that this work should be extended to include mining problems concerning the effect of hot and humid atmospheres on health and efficiency. This work was pioneered many years ago by the late Prof. J. S. Haldane and Prof. Neville Moss, and its development in the Department of Human Anatomy at Oxford, at Singapore and (during the Second World War) at the National Hospital, Queen Square, London, has yielded a knowledge of methods and an accumulation of data much of which is particularly applicable to mining problems. The Unit at Oxford has already played a part in the inauguration of similar work in the South African gold mines. The immediate inquiries on behalf of the National Coal Board will be concerned with the performance of rescue personnel at high temperatures and with the effect of age on the ability to withstand high temperatures.

Functions of the Ductless Glands: Fiftieth Anniversary

For the scientific investigator, the most difficult of all feats is to form a new idea in the face of prevailing dogma. At the end of the nineteenth century the body was regarded as a collection of organs co-ordinated and integrated by the nervous system, and the function of individual organs was explained in terms of their nervous connexions. But it was well known that a nerveless pancreas did secrete when acid food entered the intestine. Physiologists, baffled, searched for new nervous paths. Fifty years ago, in 1902, Starling, working in University College, London, suddenly had a new idea that it must be a chemical reflex, and quickly proved this by grinding up the lining of the intestine with some weak acid, injecting it into the blood and obtaining an immediate flow of pancreatic juice. This intestinal substance was called secretin because it caused the pancreas to secrete. The functions of most endocrine glands were known; but it was not until the discovery of secretin that their role in the overall organization of the body was understood. From the example of secretin, Starling and his fellow-worker, Bayliss, postulated that the higher animals possess, in addition to the nervous system, a second co-ordinating and integrating system: substances formed in one organ circulate in the blood and regulate the function of another organ or site. To these they gave the name 'hormone' (to excite), and said that, when this word was used, the attribute of messenger should be understood. This idea of a blood-borne regulation of normal body functions has proved to be one of the most fruitful in physiology, and to-day, with the advent of cortisone and adrenocorticotropic hormone, may be ready to give us a new concept of disease.

Colonial Research and Development

The debate on the Queen's Speech in the House of Commons on November 7 was concerned with Colonial affairs; but attention was focused on the situation in Kenya, and, except in Mr. Bernard Braine's speech, Colonial research received no attention. Mr. Braine, in directing attention to the importance of Colonial development, stressed particularly the urgent need for improved transport and more knowledge about the Colonies and their human and physical resources. In this connexion he referred to some achievements in Colonial research and in particular to the work of the Colonial Products Research Council. Sir Leslie Plummer supported Mr. Braine's remarks on the importance of research, particularly agricultural research. Mr. Braine pleaded for early clarification of the present uncertainty arising from the expiry in March 1956 of the Acts under which the Colonial Development and Welfare Schemes are financed. The Colonial Research Council has already pointed out in its current report that uncertainty is making the planning of long-term research impossible and hindering the recruiting of research workers for the Colonial territories. Nevertheless, no comment on this matter was made when the Under-Secretary of State for Commonwealth Relations replied on the debate.

Laterite and Lateritic Soils

In Technical Communication No. 47 of the Commonwealth Bureau of Soil Science, entitled "Laterite and Lateritic Soils" (pp. 51; from the Bureau, Farnham Royal; 1952; 6s.), J. A. Prescott and R. L. Pendleton, the distinguished authors of this publication, quote the early, lucid and authoritative descriptions given by F. Buchanan (1807) and T. J. Newbold (1844). They illustrate the strikingly cellular nature of laterite by photographs of the material when used in building, and present maps showing its wide distribution in India, Australia and Africa. Laterite occurs at shallow depth and at the surface, and the bare slag-like sheets are believed to be the exposed illuvial horizon of an ancient soil. This material has a high content of sesquioxides and is usually associated with resistant minerals and with kaolinite, which may perhaps be formed by silification of gibbsite. In discussing the mobility of sesquioxides, Prescott and Pendleton suggest that high acidity resulting from oxidation of ferrous sulphides may have a bearing on the origin of laterite. Examination of Australian laterite suggests that gallium, molybdenum, lead, vanadium and zinc are concentrated with the iron, and deficiencies of copper, manganese and phosphorus have been noted where present-day soils have developed from broken-down laterite formations; such soils are usually infertile. The red earths and red loams of the tropics are formed from a variety of rocks as well as from broken-down lateritic formations, and it is unfortunate that they have received names such as 'laterite', 'lateritic soil' or 'latosol'. Prescott and Pendleton agree with the United States Soil Survey staff that it would be better to confine the word 'laterite' to such ferruginous materials as harden on exposure and to the relicts of such materials. These relicts can be found in several

of the zonal soils, but they can usually be regarded as fossil and as accidental constituents that are not relevant to classification at the categorical level of the 'great soil groups'.

The Linnean Tradition in Sweden

That the Linnean tradition of going far afield to collect and bring back plants, thereby extending floristic and taxonomic knowledge, is still very much alive in Sweden to-day is borne out by papers contributed to a recent number of the *Arkiv för Botanik* (1, Pt. 6; 1952). Prof. Von C. Skottsberg, of the Botanical Section of the Naturhistorischen Reichsmuseums, Stockholm, has contributed a further article on the flora of San Ambrosio, off the coast of Chile ("Weitere Beiträge zur Flora der Insel San Ambrosio (Islas Desventuradas, Chile)"), while K. H. Reichinger has written both on "Plantæ novæ syriacæ" and on the flora of Turkey from collections lodged in the Stockholm herbarium.

Trace-metal Dating of Archæological Sites

New chemical and physical methods of determining the age of ancient sites are continually being suggested—the fluorine method, carbon-14, and the determination of phosphatic content of the soil are some examples. In a recent number of *Science* (116; July 4, 1952), V. P. Sokoloff and G. F. Carter contribute an article entitled "Time and Trace Metals in Archæological Sites". The metals in question are copper and zinc. These two metals, as well as others, occur in soils in several different forms, both mineral and organic, and they can be determined by analysis. Actually the authors are mainly concerned with the study of various middens outside the suitability and the time-range of the carbon-14 method. It is not suggested that this is a very sensitive form of test, but it could differentiate middens a thousand years old from those of, say, Pleistocene date.

Velocity Distribution of Sporadic Meteors

A paper by Mary Almond, J. G. Davies and A. C. B. Lovell (*Mon. Not. Roy. Astro. Soc.*, 111, 585; 1951) gave an account of the application of the radio-echo technique to the study of the velocity distribution of sporadic meteors of magnitudes 4·5–6, and a second paper (*ibid.*, 112, 21; 1952) gives further results attained from the application to fainter sporadic meteors of magnitudes 6–7·5. The apparatus was basically similar to that previously used, but additional sensitivity was acquired by increase in transmitter power and aerial gain. Two series of experiments were carried out: apex experiments during the autumn mornings of 1950; and antapex experiments during the spring evenings of 1951. Details are given of the experiments carried out during November 8–December 14, 1950, between the hours of about 5h. and 7h. in the autumn mornings. On the assumption that the meteors were moving in random directions and at the parabolic velocity limit, J. A. Clegg worked out the velocity distribution to be expected, and it was found that there was no sign of a hyperbolic velocity component. The antapex experiments were carried out between approximately 1h. and 1½h. during March 29–May 18, 1951, and the velocities measured. From the velocity distribution the same conclusion is arrived at as before, namely, that there is no sign of any hyperbolic velocity component. A very interesting feature of the curves is that the theoretical curves showing the distribution on the assumption of uniformly distributed parabolic meteors indicate much higher velocities than those derived by experiment. Not only do the results all show the absence of hyperbolic velocities, but they also indicate that a large proportion of sporadic meteors must have relatively short-period orbits. Several other matters are discussed, such as the range of magnitudes and estimates of magnitude from electron densities in the trails, and also by comparison of visual and radio echo-rates. Now that the sporadic meteors can be accepted as members of the solar system, many moving in small orbits, the whole problem of their origin may have to be considered afresh. How did these short-period particles originate, and when were they formed? It seems doubtful whether any theory at present adequately answers these questions.

Conference on Malnutrition in Tropical Africa

A conference of nutrition experts opened on November 19, at Fajara in the Gambia, British West Africa, to examine problems of malnutrition in African mothers, infants and young children. This is essentially a conference on kwashiorkor—one of many terms used to describe certain manifestations of malnutrition in young children in tropical and sub-tropical areas, especially in Africa. Kwashiorkor is now regarded as being associated with a deficiency of protein in the diet. The conference is being held under the auspices of the Commission for Technical Co-operation in Africa South of the Sahara. Delegates from the Governments of Belgium, France, Portugal, Southern Rhodesia, the Union of South Africa, the United Kingdom and African territories are to attend. There will also be observers from the Food and Agriculture Organization, the World Health Organization, the U.N. International Children's Emergency Fund and the International Children's Centre. The United Kingdom delegation includes Profs. B. S. Platt and A. A. Moncrieff from London and experts from the West, East and Central African territories.

Survey of Applied Mathematics in the United States

The United States National Academy of Sciences, under contract by the National Science Foundation, is to make a broad survey of research and training in applied mathematics in the United States. The survey, to be carried out with the co-operation of the Office of Naval Research, the Office of Ordnance Research of the Army, and the Office of Scientific Research of the Air Force, is expected to take one year, and Dr. F. Joachim Weyl, head of the Mathematics Branch, Office of Naval Research, has been loaned to carry out the work with the advice of a committee selected by the Division of Mathematics of the National Research Council. The survey group will seek to determine the nature and extent of research in applied mathematics being carried out by government organizations, universities and industry, and will also report on the training and teaching in the subject, with an indication of the areas which are not receiving adequate support. As part of the study, a conference on training and research needs in applied mathematics will be held during the spring of 1953 to consider the findings of the survey and to examine the future of research and teaching in this field. In general, this survey will be on the lines of that on physiology being carried out by the American Physiological Society, also under contract by the National Science Foundation (see *Nature*, August 16, p. 268).

UNIVERSITIES AND UNIVERSITY COLLEGES IN GREAT BRITAIN

FOR its publication, "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1950–51"*, the University Grants Committee has continued the small format introduced last year. While the record number of students of the previous year was not attained, the decrease was only slight—85,314 instead of 85,421—and the proportion of assisted students also remained high (72·5 per cent compared with 72·8 per cent during 1949–50 and 73·7 per cent during 1948–49); the dependence on Parliamentary grants again increased and now represents 64·9 per cent of the recurrent income, 16·6 per cent coming from fees (compared with 17·7 per cent during 1949–50), 5·5 per cent from endowments and 4·3 per cent from grants from local authorities, as against 5·7 per cent and 4·6 per cent, respectively, during 1949–50. The ratio of staff to students again increased, the full-time teaching staff being now 8,603 compared with 7,930 during 1949–50. Although the number of professors increased by 48 and of readers, assistant professors and independent lecturers by 62, the increase was mainly in the grades of lecturers (360), assistant lecturers and demonstrators (83) or other grades (120). Separate figures are now given for the Colleges and Schools of the University of London for full-time staffs, income and expenditure and libraries.

Of the full-time students, 67,743 were reading for a first degree, 6,244 for a diploma and 11,327, together with 4,158 of the 16,698 part-time students, were engaged in research or other advanced work; 64,180 full-time students were in England, 5,133 in Wales and 16,001 in Scotland, the decrease in Scotland thus offsetting an increase of 776 men and 247 women in England; in Wales there were 216 fewer men but 65 more women. Of the total, 15,098 were at Oxford and Cambridge, 18,412 at London and 30,670 at other English universities and colleges. Only at Bristol and Liverpool were there increases of more than a hundred students. The total for London colleges and schools increased by 913. Elsewhere there were decreases or slight increases. The North Staffordshire University College appears in the returns for the first time. The proportion of full-time students residing in colleges and halls of residence increased to 24·3 per cent, but is still less than in 1938–39 (25·1 per cent), although the number in residence is greater (20,732 compared with 12,555). The proportion of women in residence is still nearly double that of men (38·9 per cent compared with 20 per cent); 39·1 per cent of full-time students were in lodgings and 36·6 per cent at home, compared with 33·2 and 41·7 per cent, respectively, before the War. There was a further slight increase in overseas students compared with 1949–50: 3,657 full-time and 1,628 part-time students came from within the British Commonwealth and 2,902 full-time and 1,290 part-time students from foreign countries. Of the 22,223 students admitted for the first time in 1950–51 (a decrease of 2,108 on 1949–50), 20,292 were reading for a first degree and 1,931 for a diploma, and, of those reading for a first degree, 1,836 were less than eighteen years of age and 11,656 were nineteen or more.

Although the distribution of full-time students did not differ significantly from that during 1949–50, some of the changes in numbers are noteworthy. Arts students represented 43·1 per cent of the total; those in pure science 20·1, in medicine 16·6, in technology 12·4, in dentistry 3·4, in agriculture 3·1, and in veterinary science 1·3 per cent. Of the full-time advanced students, 24·9 per cent were working for a diploma and, of the remainder, 38·8 were in arts, 34·0 in pure science, 11·9 in medicine and dentistry, 11·8 in technology, and 3·3 per cent in agriculture. While the number of full-time students in arts decreased by 455 to 37,243 and those in science increased by 251 to 17,168, there was a decrease of 342 in the students of technology. In spite of the slight increase of 54 in advanced students of technology, there is no evidence in these returns of any response to the call for more university-trained technologists sounded so urgently more than two years ago. Medical students were almost stationary at 14,201, and students in agriculture decreased by 167 to 2,606. An increase of 391 in veterinary science students was due to the incorporation in the University of London of the Royal Veterinary College with 380 students. Of the full-time students, 37,714 out of 49,999 men and 9,627 out of 14,181 women in England were receiving assistance in the way of scholarships, exhibitions or other awards from public or private funds: for Wales, the corresponding figures are 3,314 out of 3,822 men and 1,095 out of 1,311 women; and for Scotland, 8,144 out of 12,010 men and 1,950 out of 3,991 women. The percentage of assisted students in England ranged from 77·9 per cent in the provincial universities, to 65·9 per cent in the University of London; Oxford and Cambridge with 75·7 and 74·3 per cent, respectively, thus came between the two. Of the 65,831 full-time men students, 37·2 per cent were in arts, 21·1 per cent in pure science and 15·8 per cent in technology; for the 19,483 women students, the corresponding figures are 63·0, 17·0, 15·1 and 1 per cent. Medicine and dentistry claimed 44·6 per cent of the part-time advanced students, arts 30·4, technology 9·6 and pure science 8·7 per cent, compared with 45·1, 32·8, 10·8 and 10·8 per cent, respectively, in 1949–50.

The recurrent income of the universities and university colleges of Great Britain increased by £2,258,388 to £24,268,123, of which £15,767,002 was from parliamentary grants, £4,022,459 from fees, £1,329,916 from endowments and £1,040,037 from grants from local authorities. Of the total income from public funds of £16,807,039 and £7,461,084 from other sources, the University of London received £5,075,985 from public and £2,070,651 from other sources; the University of Cambridge similarly received £1,043,657 and £1,080,845; for Oxford the corresponding figures are £945,830 and £729,499; for Manchester, £912,718 and £277,390; for Durham, £720,392 and £315,985; for Birmingham, £724,752 and £271,994; for Bristol, £633,976 and £299,369; for Leeds, £700,876 and £245,261; and for Liverpool, £665,317 and £246,085. No other English university or university college, except Sheffield, with £607,415, had an income exceeding half a million pounds, though three universities in Scotland exceeded this

* University Grants Committee: Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1950–1951. (Cmd. 8638.) Pp. 44. (London: H.M. Stationery Office, 1952.) 2s. net.

figure: Aberdeen, with £404,450 from public and £134,337 from other sources; Edinburgh, with £738,037 and £345,198; and Glasgow, with £835,650 and £361,388, respectively. The University of Wales, including the Welsh National School of Medicine, received £847,960 from public funds and £327,164 from other sources.

Of the total expenditure of £24,269,862, an increase of £2,501,952 on the previous year, administration accounted for 8·7 per cent, departmental maintenance 69·7, maintenance of premises 11·1, and miscellaneous expenditure 9·4 per cent. Capital expenditure met from reserves amounted to £254,274 and allocation to reserves, £236,707; for 1949–50, these figures were £472,327 and £270,993, respectively. Departmental maintenance included salaries of teaching and research staffs and payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums, and the supply of materials, apparatus, books, specimens, etc. Salaries and superannuation amounted to £11,895,971, an increase of £1,349,625 on the previous year; this represents 49·1 per cent of the total expenditure, compared with 48·4 per cent in 1949–50 and an 8·5 per cent increase in full-time staff.

Library expenditure, excluding general maintenance of library buildings, rates, heat, light, repairs, etc., amounted to £891,385 compared with £788,402 in 1949–50, the percentage of total university expenditure remaining 3·7 per cent. Of this total, £473,087 was for salaries and wages, £197,062 on account of books and £103,305 on periodicals. The University of Oxford spent £32,095 on books, and Cambridge £10,102, while a total of £51,025 (including £7,027 on the Central Library, £5,678 at the London School of Economics and £5,006 at University College) was expended for this purpose in the colleges and schools of the University of London. Nine other universities, Birmingham (£5,102), Bristol (£5,467), Leeds (£6,638), Liverpool (£8,111), Manchester (£9,092), Aberdeen (£6,995), Edinburgh (£9,648), Glasgow (£8,933) and St. Andrews (£5,307), spent £5,000 or more on books, but only London (£30,496), Cambridge (£7,542), Glasgow (£7,263), Manchester (£5,228) and Oxford (£5,175) spent a like sum on periodicals.

While these returns show that university expansion in Britain has now been halted and afford signs, as in the increasing ratio of staff to students and the slight decrease in the proportion of art students, that the universities are already adjusting themselves to current requirements and seeking to maintain or raise standards, they also contain evidence of the vulnerability of such standards to extraneous pressure with the growing dependence of the universities upon State assistance. That in itself supports the contention of the Select Committee on Estimates in a recent report regarding the desirability of giving the fullest possible information to Parliament concerning the expenditure of the grant-in-aid of universities and colleges. A Treasury Memorandum included in the Eleventh Report from the Select Committee on Estimates for the Session 1951–52 (No. 289. London: H.M.S.O. 9*d*. net) accepts the recommendation of the Estimates Committee that a note should be inserted in the estimates reconciling the amount of the quinquennial grant proposed for the academic year with the total figure of recurrent grant shown in the estimates for the financial year, but the Treasury does not consider that the estimates are the most convenient vehicle for giving information to Parliament on changes in recurrent grants. The Treasury proposes to consider the best way of making any specific changes known to Parliament, but rejects the Estimates Committee's further recommendation that the Comptroller and Auditor-General should have the right to inspect the books and accounts of universities in respect of non-recurrent grants for capital development. The Treasury considers that the existing audit of university accounts already ensures that the grant is used for the purpose for which it is intended. The detailed scrutiny of expenditure on the design and equipment of buildings inevitably raises questions of academic policy, and in the Treasury view goes far beyond the broad lines on which control should be exercised if academic freedom is to be unimpaired. The Treasury believes that such scrutiny is best left to the University Grants Committee, and it is satisfied that this Committee, with the help of its own works and buildings sub-committee and of the Ministry of Works, scrutinizes all plans for which aid is sought and requires the universities to accept the lowest tender for their work unless good reason can be shown to the contrary.

The Treasury's attitude on this point is evidence of how firmly entrenched in Great Britain is the desire to safeguard academic freedom; but the universities are now too vulnerable to external conditions for the position to be regarded with complacency. The Treasury memorandum indicates that in accordance with a further recommendation of the Estimates Committee the terms of reference of the University Grants Committee will be revised to remove the obligation to collect, examine and disseminate information on university education abroad. Approval is also expressed of the recommendation regarding continuity in the senior full-time posts of the University Grants Committee.

ELECTRICAL ENGINEERING IN BRITAIN

THE inaugural address of Colonel H. B. Leeson, on taking office as president of the Institution of Electrical Engineers, was delivered on October 9, his subject being "Electricity and Current Affairs". The relationship of the electrical industry to the economic position and prospects of Great Britain was the central theme of the address, which presented not only a detailed picture of the situation of the industry in question, but also set this in perspective in its world background. "For generations," said Colonel Leeson, "cotton and coal have been the staple of our oversea trade; engineering is the staple of the future." In 1951 roughly 39 per cent, or just over £1,000 million, of the value of the exports of all kinds from Britain represented engineering products, and, of this, £189 million came from the electrical industry.

In tracing the growth of the industry during the past fifty years, Colonel Leeson pointed out that the value of the output of the electrical manufacturers, which in 1907 was £14 million, had been estimated for the year 1951 at £700 million and, in that year, nearly six hundred thousand people were employed. Although the electrical industry thus already plays a substantial part in the country's economy, it is destined to play a greater one in the future, and the further expansion of the industry must be considered

in relation to the general pattern of the national economy. The drive to balance Britain's overseas account by increased exports requires a very large expansion in the volume of engineering exports. Dealing with the difficulties besetting the achievement of this increase in exports, Colonel Leeson said, "The shortage of coal, our only natural resource, is obviously the major cause of our present instability. Of equal significance is the fall in human effort—in its broadest sense of every form of human endeavour. Typical of the causes of this falling off in human effort are the effects of shorter normal hours of work, the longer time spent in education and training coupled with National Service, and the changing structure of the population. These together have brought about shortages in every direction, such as in food, materials, houses, fuel, power, transport and production generally. All these factors in turn have induced alternating notching up of costs and wages without lasting benefit, unless it be to our foreign competitors; but with lower standards of life for many. The factors are so interlinked in their cumulative effects that it is difficult to know which is cause and which is effect".

There is, of course, a correlation between the activity of the manufacturing industries and the consumption of electricity by the nation, and it is here that the position compares very unfavourably with that of the United States, where the electrical power used per worker is nearly 2½ times that in Britain. The urgent need for the installation of more generating plant is, of course, only too evident in the load shedding which has become customary in recent years. The attainment in Britain of a yearly rate of plant installation of 2,000 MW. is imperative, and a capital investment policy covering this rate of installation is an inescapable economic necessity.

The four basic needs for economic recovery and development in Great Britain are, in Colonel Leeson's opinion, more human effort (that is, more man-hours of work); greater production of the basic commodities such as food, coal, metals, chemicals and other essential materials; more fuel and power for industry and the home; and more capital (that is, greater savings by government, industry and individuals). "We are facing," he said, "a choice and a challenge. Are we, as individuals and a nation, content to accept with complacency the relentless trend of current affairs towards lower standards of living, or alternatively, do we take up the challenge this represents, and by courage and the exertion of more strenuous individual effort on things that really matter, change the trend towards recovery and better times?"

A considerable part of the address was devoted to reviewing the growth of employment in the electrical industry in its various branches, and Colonel Leeson gave interesting data on the distribution of professional engineers as represented by membership of the Institution of Electrical Engineers in the major subdivisions of the industry. The total number of people employed in the three main branches of the industry, namely, manufacture, electricity supply and electrical contracting, was, in 1951, nearly 846,000. Roughly 70 per cent of this total were employed in manufacture, 22 per cent in supply, and the remaining 8 per cent in contracting. The membership of the Institution of Electrical Engineers, exclusive of students, numbers 31,000, and an analysis of the percentage of this membership by occupation is as follows: manufacture, 29·8; government services, consulting engineers and others, 22·6; electricity supply, 20·6; communications, 10·0; research, education and training, 9·9; and installation and maintenance, 7·1. 18 per cent of the Institution's members are serving overseas.

The education and training of all classes of personnel in the industry are, in these days, matters of exceptional importance. The direct interest of the Institution of Electrical Engineers is by its charter limited to the professional engineer; but the Institution does concern itself with the improvement of facilities for technicians and craftsmen, and it co-operates with the British Electrical and Allied Manufacturers' Association and the Radio Industries Council to that end. Colonel Leeson emphasized the close partnership in which industry, technical colleges and universities are associated in this matter of the education and training of engineers, and he urged the recognition, in relation to professional engineers, of valuable features in industry-based 'sandwich' and part-time courses which are complementary to the full-time courses of universities and technical colleges.

The problem of the needed expansion of higher technological education can, in Colonel Leeson's opinion, best be tackled by the selection, on a regional basis, of a few of the existing major technical colleges for expansion and development. These should enjoy academic freedom under a self-governing representative administration and be free from any direct control by the local education authority. "The first essential to this objective is the setting up of a small body (including a few men of high academic and professional status) under the ægis of the Government with the necessary finance and authority to select and guide the chosen colleges in consultation with professional bodies, learned societies, and industry. It would be the duty of every section of the industry to provide facilities for additional and improved training matched to the higher standard of education—a duty rich in its own economic reward."

PLASTICITY OF MATERIALS

A CONFERENCE on plasticity, arranged by the British Society of Rheology, was held in the University of Southampton during September 25–27.

The diverse nature of the problems encountered in flow technology, problems which still lack a fundamental treatment, was strongly evidenced in the discussions which arose on the papers presented. In spite of their diversity, however, it is remarkable how many of these problems derive from the basic problem of test instrumentation. The momentum of rheological inquiry is still sustained, in the main, by those immediately concerned with the behaviour of real commercial materials, working with instruments designed to give some rapid index from which the relevant property can be deduced. These instruments have been evolved in turn from those developed in more fundamental laboratories where the properties of plastic materials made classical viscometry meaningless. This necessary departure in experimental design was, unfortunately, not accompanied by an equivalent development in theoretical treatment, and the situation has become gradually worse as instruments involving more complex stress-systems have been produced on grounds of general utility. The whole line of inquiry, from that of pure research on simple systems and idealized models to that of the actual behaviour of industrial products under

conditions of use, is one which can profit from the experience of those working on other parts of the line. Disagreement still exists, often on quite basic concepts; but the general process of unification, by theory and experiment, continues.

Instrument design, the difficulties of assessing standards, reconciliation of the results of different test methods—such questions as these are of primary concern to the applied rheologist. Dr. J. R. Scott (British Rubber Manufacturers' Research Association) made it plain that no single plastimeter can meet all the requirements of the rubber industry. Either, as in the rotation-type, the shear-rate is limited, and problems of slip at the containing surfaces arise; or else, as in the Williams press-type, while simple repetitive testing can give reproducible results, the system does not appear to be one which can assist the more fundamental approach to the subject. This problem of widening the scope of industrial instruments has been faced by Mr. G. E. Bessey and Mr. K. A. Lammiman (British Whiting Federation Research Council), who described an apparatus, ingeniously adapted to a lathe bed, which can test at constant rates of extension or compression, recording load and extension on a drum. The grip problem in the extension tests is overcome by extending a specially formed closed loop of the material. The machine can also be adapted for rotation tests, recording the stress against the rate of shear, and can handle material of a wide consistency. The results are of striking reproducibility—a rare quality in plastic testing.

Data derived from such instruments are still difficult to relate significantly to other measured quantities. This aspect of interpretation of data was treated by Mr. E. B. Atkinson (*BX*-Plastics, Ltd.), mainly in relation to extrusion and the problem of errors of boundary condition. The simple assumptions of extrusion analysis (those applicable to viscometers using Newtonian liquids at low rates) can all be violated, and these effects, together with the temperature gradients that arise, lead to unusual flow phenomena. The flow curves are difficult to treat theoretically; but a basis for such a treatment—and a general equation—was proposed, and this could be reconciled with an examination of the problem in terms of dynamic similarity. Such treatments are often open to criticism on *a priori* mathematical grounds, but any approach which advances the design of the processing stages will be of positive value to the plastics industries.

Interpretation, then, has its difficulties; and if an applied laboratory device can reproduce the practical conditions to such a degree that similarity can be claimed, then one stage of interpretation is directly bridged, and the problem is reduced to a true model. This, as an aspect again of rheological instrument problems, was exemplified in a paper by Dr. G. G. Meyerhof (Building Research Station, Garston), whose investigations into the behaviour of clay blocks when compressed between plates of various shape are direct analogies of the building problems of structures where the foundations (or footings) form the upper plate, and the surface of the bed below the clay forms the lower. The yield pressure of such blocks increases rapidly with the adhesion of the material to the plates, and also with decreasing block-thickness. The results are in accord with the theoretical estimates of the yield pressure, and with the assumed mechanism of failure. The unusual occurrence of a gas-holder breaking its back enabled a field investigation to be carried out, and, when the formation of the bed below the clay was traced, the results (treated according to the foregoing theory) provided a stress distribution which beautifully accounted for the result of this impressive large-scale experiment. Mr. P. Mason (Building Research Station, Garston) provided further evidence of progress in establishing the behaviour of building materials. A compression test, of a type originally suggested by Roller, was applied to various plaster mixes, and the extraction of one index—namely, the slope of the experimental line (a log–log plot of empirical quantities which approximate to stress and strain)—provided a grading the sequence of which agreed exactly with that which field-workers, on the basis of experience, accorded to the materials.

A more fundamental instrument-technique was described by Dr. W. W. Barkas and Mr. G. N. Christensen (Faculty of Technology, University of Manchester). This has been developed for a study of the behaviour of wood fibre – water assemblies, similar to those used in the manufacture of paper. These assemblies are formed as small cylinders, placed on a sintered-glass plate and connected by wet contact to one arm of a manometer. Changes in the manometer pressure effectively vary the hydrostatic pressure applied to the assembly, and hence stress – strain studies may be made. As the stiffness of the fibres, and the size of the capillaries in such an assembly, effectively control the type of paper produced in the industrial processes, such results have direct applied importance.

Some problems arising in the choice of materials for aircraft purposes were discussed by Dr. E. W. J. Mardles (Royal Aircraft Establishment, Farnborough). Temperature specifications for such materials as greases are severe, a working range being demanded from conditions of high-altitude cold to those of local engine heat. The required properties of lubricants may be masked by effects which are functions of the instrument—surface tension effects, for example, giving rise to an apparent plasticity. The properties of certain gels are also of importance in aircraft research (cellulose acetate, for example), and the time-dependent properties of such materials were surveyed.

The conference opened with two papers concerned with the fundamental interpretation of plastic flow phenomena. Dr. A. J. Kennedy (Royal Institution, London) reviewed the experimental information available on the mechanisms involved in the creep of polycrystalline metals, and, taking such evidence together with that provided by a wide range of non-metallic materials characterized by a strength – weakness structure (long-chain compounds; mixes and aggregates of various kinds), suggested that the phenomenon of transient creep is an outcome of fairly simple statistical considerations, resulting in parabolæ with time powers which fall very closely about that of the Andrade one-third power. The behaviour of a macroscopic mechanical model was reported: this approximates to the kind of curve exhibited by practical materials. Translation into physical terms is difficult, but the physics of a system which would fulfil the requirements was outlined, and this has interesting analogies with the question of the representation of voters in a two-party electoral system.

Mr. A. Graham (National Gas Turbine Establishment) approached the representation of creep data from the same general point of view, namely, that the striking fact emerging from plasticity results is

that different materials behave so similarly. Using observations on a heat-resistant alloy at high temperatures, attempts were made to find an equation capable of general application. By a process of trial and error, an equation was developed from those of Nutting and Boltzmann which can be shown to be a special case of the fractional differential equation of Scott-Blair. This equation is capable of successfully embodying the four variables—strain, stress, time and temperature—and is able to fit the various types of creep curve encountered. It is true that several constants may be involved in the more complex cases, but this is defended on the grounds that mechanisms must certainly be multiple and complex, and particularly so in the case of metals.

A. J. KENNEDY

BRITISH ELECTRONIC INSTRUMENTS IN RESEARCH AND INDUSTRY

DURING the period September 2–5 the Scientific Instrument Manufacturers' Association of Great Britain held, in London, an exhibition of electronic instruments, and associated with this was a symposium of papers describing the application of such instruments in research and in industry. This was the fourth such gathering in a series which began in 1948, the previous exhibition being in 1950, and it is now proposed to hold future symposia and exhibitions biennially.

The papers read at the symposium covered a wide field of instrumentation. At the first session a description was given of electronic control systems for large astronomical telescopes. After a discussion of the factors leading to the requirement of very accurate control of 'rate' in drives for such telescopes, there followed a review of techniques used up to the present time for achieving this purpose, culminating in the present-day forms of electronic control. A modern requirement is the ability to introduce small variations of rate, and to this end use has been made of very stable resistance-capacity tuned oscillators, either as the actual source of a reference frequency or as the means of introducing some frequency variation of a crystal-controlled source. Reference was also made to a 'photographic zenith tube', shortly to be installed in Great Britain, which will provide a new standard of absolute time determination.

An account was given at the next session of the development of resistive elements and wave-guide attenuators from a semi-conducting ceramic. In contrast to the majority of semi-conductors, pure zinc oxide has a temperature coefficient of resistivity which can be controlled between high positive and negative values; the addition of titanium dioxide makes it possible to achieve this control with commercially available materials, and to control the value of the resistivity. Small resistors, up to ten thousand ohms, and having tolerances and stability similar to grade-*B* carbon-composition resistors, have been made, and these may be used with surface temperatures up to 200° C. The material has proved to be very satisfactory for the manufacture of dummy loads to fit in metal wave-guides, as it is unaffected by rapid changes of temperature; these loads absorb microwave energy strongly and also provide a good impedance match in the wave-guide.

Research and development based on precise methods of measurement are responsible in a large degree for the progress upon which the electrical industry depends. Among other topics discussed at later sessions of the symposium were electronics in strain measurement, and electronic measurement and control for industry. In the field of strain measurement, such features as multi-channel strain-display equipment, high-speed self-balancing strain bridges, load cells, load indicators and torque meters were dealt with.

The use of ultrasonic vibrations in many diverse applications has been made possible by the development of electronic methods for the generation of such vibrations, and the final paper of the symposium was concerned with this subject. The applications for industrial purposes cover processes of emulsification and the production of finely divided suspensions; in these processes the action required is that of the dispersion of one material in another. The same principle is involved in the action of cleaning, and the use of ultrasonic techniques has been proposed both for scouring textiles and for the removal of foreign matter from solid bodies. All these effects depend upon the phenomenon of cavitation, which also makes possible the tinning of aluminium by a method involving the use of vibrations of ultrasonic frequency. Other metallurgical applications include the degassing of melts and grain refinement. Most chemical effects occur at relatively slow reaction-rates, but ultrasonic depolymerization has been widely studied: in the biological field micro-organisms have been destroyed, and claims of striking therapeutic results have been made. It appears, however, that there still remains some doubt about the practical usefulness of some of these applications, particularly in cases where high intensities of ultrasonic energy are necessary.

Many different kinds of instruments were to be seen in the exhibition which accompanied the symposium. There were examples of improved design in instruments of various types shown on earlier occasions: instruments for the accurate measurement of power, voltage, current and resistance, and also several items of equipment—signal generators, valve testers, impedance bridges, *Q*-meters—which are now the indispensable tools of the radio engineer. In addition, examples were shown of relatively new developments.

The use of direct-writing instruments for recording variable electrical quantities has until recently been confined to cases in which the rate of change was comparatively small, and direct recording was not possible when frequency components exceeding a few cycles per second occurred, the only recourse then being to photographic recording with Duddell or cathode-ray oscillographs. A new recorder has now been developed which has a moving-coil element so efficient that it may be driven by a simple valve amplifier, but which yet has sufficient restoring torque to deflect a stylus across the paper record in as little as 2·5 msec. It is thus now possible to obtain records of high-speed phenomena directly in a dry and permanent form. The suspension of the recorder is of a stiffness which makes the instrument robust enough for use in aircraft or vehicles.

With the increasing demands for maximum efficiency in temperature measurement, cold-(thermo) junction temperature control has become a factor of major importance. A new, mains-operated thermostat has been designed which overcomes the diffi-

culties and problems of such control encountered in the past. The thermostat will stabilize the temperature of the cold junction to an extent that variations will not exceed 0·1 deg. C. There are therefore no temperature changes to note, nor is ice or liquid required. The instrument is arranged normally to be set to a temperature in the range 42°–48° C., and takes about forty-five minutes to reach stable conditions after switching on.

The needs of the chemist have not been neglected: instruments are now available which will give a continuous indication of the *p*H of any given liquid under examination, so that rapidly changing conditions may be followed without difficulty. These meters are automatic in operation and can be used in conjunction with a recorder to provide permanent records. Also for the chemist is the conductivity controller: electrolytic conductance measurements afford a convenient and sensitive method for determining a number of factors of basic importance in industrial processes, and the usefulness of such measurements is greatly increased when they are applied to the automatic control of the process being monitored. The instrument shown consisted of a modified Wheatstone bridge network operated at a frequency of 2·9 kc./s., and incorporated an amplifier and relay circuit which enable electrical process control to be effected.

Examples of various miniature circuit units were to be seen at the exhibition. Silver conductors are screen-printed and fired, and resistors are formed with a series of baked-on graphite dispersions. The range of resistivities is from 10 ohms to 1 megohm per square, and one type of dispersion will withstand a temperature of 200° C. for one hour with no more than 1 per cent change in resistance. The resistor noise is of the same low order as that of grade-1 resistors (cracked hydrocarbon type). Ceramic capacitor tablets covering the range 1–10,000 μμF. per unit are available.

The exhibition showed that British instrument makers are keeping abreast of the times, and, in all fields of instrumentation where electronics can play a useful part, it is evident that the user may continue to expect to have new tools placed at his disposal.

J. A. Saxton

MEDICAL RESEARCH COUNCIL

REPORT FOR THE YEAR 1950–51

THE report of the Medical Research Council for the Year 1950–51* follows the policy of the Council, initiated in the preceding report, of giving, not a complete picture of all that the Council is doing, but a selective account of its activities which discusses the most important work in progress, together with discussions of particular trends of the Council's activities. The report also contains a single classified list of papers published by the Council's individual research workers, an outline of the Council's research programme and the research programmes of each of its many Departments, and lists of the personnel of each of these Departments. An appendix to the report for this year gives in full the text of the memorandum on the future organization of medical research, submitted to Parliament in 1918 by the late Viscount Addison, a memorandum which placed the Medical Research Council under the authority, not of the Ministry of Health, but of a Committee of the Privy Council. Anyone who wishes to understand Viscount Addison's reasons for this wise move will find them here explained. Another section of the report pays tribute to the considerable labours of Viscount Addison on behalf of British medicine.

The particular trend of the Council's work that is discussed in the report is "The Training of Research Workers". The discussion of this important subject recognizes that the main responsibility for training these workers rests on the universities, with which the Council has always been closely associated. Agreeing with the late Sir Charles Sherrington that the best way to get scientific fruit is to cultivate the tree, the Council has from the first given grants to support research assistants in university and other departments and has helped to provide opportunities for the training of junior workers in the research of their own establishments. Recently the Council has increased facilities for research workers. It believes that by far the best training for them is actual investigation under the guidance of an expert, and a flexible scheme for the assistance of the training in research has been devised. This scheme is intended to meet individual needs, and there are three main aspects of it: research scholarships (formerly called studentships), clinical fellowships and travelling fellowships.

Postgraduate scholarships are intended for those who have graduated recently in medicine or science, although they include also arrangements for more senior workers, and supplement opportunities provided by the universities. They are available for workers training in any branch of medical science and are awarded for one year, being renewable for a maximum of three years. This scheme began in 1944, and 221 scholarships have so far been awarded. More than half of them have been for subjects allied to chemistry, and a quarter have gone to workers interested in the preclinical subjects.

The clinical fellowships are intended for more senior workers and were created because postgraduate studentships (scholarships) attracted few medical graduates to careers in clinical research. The stipend is that of a registrar in the National Health Service, and they carry continuation of the superannuation provided by departments of health. Provision is also made for any non-clinical work that may be necessary. Any academic or hospital department sponsoring an applicant is required to undertake to give the applicant an opportunity to return to that department if he desires to do so.

The Council has five groups of travelling fellowships at its disposal: Rockefeller fellowships in medicine, Eli Lilly research fellowships in medicine, Dorothy Temple Cross fellowships in tuberculosis, Alexander Pigott Wernher Memorial Trust fellowships in ophthalmology and otology, and French exchange scholarships in medical science. The first two groups are available to workers in clinical and non-clinical subjects, the third and fourth in the special subjects stated, and the fifth in non-clinical subjects only. All are normally tenable for one year. The report describes these fellowships and gives a table that summarizes the careers of those who have held them in the past.

* Committee of Privy Council for Medical Research: Report of the Medical Research Council for the Year 1950–51. (Cmd. 8584.) Pp. iv+214. (London: H.M.S.O., 1952.) 6s. net.

The selective account of the Council's work entitled "Some Aspects of Medical Research" is, like the similar section in the preceding report, a valuable discussion of modern knowledge of the following subjects: research on proteins, the preservation of spermatozoa and other cells at low temperatures, statistics in medical research, whooping cough, tuberculosis, antibiotics, diseases of the eye and skin, the experimental study of human skilled performance, climatological medicine, cortisone and adrenocorticotropic hormone, malaria, and insecticides. It is impossible, in the space available in this article, to do more than indicate in this way the scope of this interesting section. It does not cover, and it is not intended to cover, the full extent of the Council's activities and interests, the breadth of which is realized only by a study of the research programmes of the Council's numerous departments.

The reports of the Medical Research Council, and also those of kindred organizations, reveal the noble uses to which scientific work is actually being put. Not only is science daily saving the lives and mitigating the suffering of human beings and animals; it is also extending the span of life, fitting it to the demands of modern civilization and preparing for later generations a better and a healthier world. There is much in the history and literature of the world to remind one of man's desire to help his fellows and other living things; but readers of the reports of the Medical Research Council may well ask themselves where else, outside unpretentious documents such as these, a man may find a comparable record of human labour entirely devoted to the welfare of mankind. G. LAPAGE

PHOTOGRAPHY IN RESEARCH AT THE UNIVERSITY

ON October 4 nearly two hundred people gathered at the Zoology School, Cambridge, to hear a series of short papers on the applications of photography to research in the university. This very successful all-day symposium was organized by the Scientific and Technical Group of the Royal Photographic Society and made possible largely through the enthusiastic co-operation of a number of Cambridge workers, including Prof. J. Gray, Dr. R. H. J. Brown, Mr. A. M. P. Brookes, Mr. Fairfax-Fozzard and Dr. J. S. Courtney-Pratt.

Mr. V. Gallafent opened the symposium by outlining the aims and objects of the Scientific and Technical Group in the advancement of photography. The Second World War, and its after-effects, have prevented the Group from acting on its agreed policy of fostering subsections in the provincial centres. The present meeting at Cambridge marked the first real step towards the realization of this policy; and it was clear that it was a popular one.

A résumé of photographic reciprocity failure by Dr. W. F. Berg led to an interesting discussion on the merits of latensification by a long, low-intensity exposure after the short camera exposure. Mr. G. S. Moore urged, from the floor, that full development in a low-contrast metol developer would give as much speed as could be achieved by latensification, but possibly the latter process gives finer grain at a given γ (which defines contrast in the image).

In a very clear paper, Mr. A. M. P. Brookes presented what might best be called a system of approach to any problem in high-speed photography as applied to engineering. It is usual to decide the exposure-time first. Still and ciné techniques differ inasmuch as the shutter-speed for a photograph destined to be examined as a still needs to be shorter than that for a ciné frame, where slight blurring helps to produce a jerk-free movement on projection. Mr. Brookes showed a graph from which the exposure-time could be read off against subject-speed after allowing for scaling-down in the camera. The graph was based on a 0·1-mm. movement of image on the emulsion. For illumination of the subject, counting the light output from a photoflood as 1, a studio light would be 10, a high-intensity mercury arc 50, a flashbulb 1,000, and a discharge tube 10,000.

Dr. R. H. J. Brown, of the Department of Zoology, Cambridge, was principally interested in the study of animal movements—the flexure of a pigeon's wings, fish swimming, etc. He dealt, in his paper, mainly with the problems of illumination. For micro-cinematography the BTH type *FA5* lamp having a source 4·5 mm. in length is very good. It can be run continuously at 125 W. or flashed at a rate equivalent to 3½ kW.

Mr. H. S. L. Harris described experimental difficulties in connexion with the bringing into operation of a mercury-vapour flash-tube for the photoelastic study of the stressing of gear teeth while running under load.

In the afternoon session Mr. R. G. Horner read a short paper on the limitations of colour photography in the recording of colour. Colour photography is sold to the public in order to give pleasing pictures, and it was never intended as a simple short-cut to colorimetry. When used for recording colours, it is necessary to apply all the standard photometric techniques used in photographic photometry.

A particularly interesting paper was presented by Prof. J. S. Mitchell (professor of radiotherapeutics in the University of Cambridge) dealing with ultra-violet and fluorescence photography, particularly that of cancerous tumours. Work is in progress on the relation between the disturbance of cellular nucleic acid metabolism (as revealed by ultra-violet absorption) and the production of structural changes in chromosomes by the therapeutic doses of irradiation.

Animal experiments have confirmed the increased fluorescence to ultra-violet light of the actively growing parts of the tumour and some other tissues following the injection of tracers. Prof. Mitchell appealed for guidance in colour-photographing the yellow fluorescence of the dissected tissues so as to yield quantitative results. A similar appeal was made by Dr. K. W. Rizk, who is engaged in recording the flow patterns that occur when water containing a blue indicator (such as litmus) is injected into a tank containing a colourless solution that turns the indicator red. Dr. Rizk was disappointed to find that the boundary between the blue central cone of the jet and the red mantle varied according to the camera exposure. No help was forthcoming from the meeting for Prof. Mitchell or Dr. Rizk beyond a re-emphasis of the limitations of commercial colour-processes.

In the section on radiation microscopy, Dr. V. E. Cosslett (Cavendish Laboratory) considered the suitability of photographic materials for electron and X-ray work. For ordinary work the available materials are satisfactory, but for some purposes it would be advantageous to have specially improved materials. Dr. Cosslett appealed for more work to

be carried out on the relationship between electron voltage and the characteristics of the photographic materials exposed to them. Very puzzling is the marked difference in response of photographic emulsions to electrons and X-rays.

Dr. J. W. Menter (Physics and Chemistry of Surfaces Laboratory, Cambridge) showed some very fine electron-reflexion micrographs of solid surfaces. These were obtained using a Metrovick *E.M.*3 electron microscope that had been adapted for reflexion work.

Mr. W. D. Kemp dealt with the application of television to the recording of motion-picture films. There is no space here to follow the detailed technical argument, but it was summed up well in the short film that was projected. The quality was far above anything seen on the broadcast television screen. Questioned as to whether the lines had been eliminated by spot-wobble, Mr. Kemp replied that they had been visible on the negative but were lost in the printing stage.

In the last paper of the symposium Mr. J. G. Yates described the experimental difficulties attending the slow-speed recording of low-frequency 'noises' such as the spontaneous variations in carbon resistors that occur under load.

FULMER RESEARCH INSTITUTE

OPEN DAY

AN open day was held at the Fulmer Research Institute on September 30 to mark the completion of the first five years of work at the Institute; it was also the occasion for unveiling a memorial plaque to the founder, the late Colonel W. C. Devereux. After welcoming the guests, Mr. Percy Horsfall, chairman of the group of companies forming Almin, Ltd., explained that the Institute has been provided with the necessary capital by his organization, but that the Institute facilities are available to all without any preference to the Almin group. In the absence of Lord Hives, who had gone abroad, the unveiling ceremony was performed by Sir Archibald Rowlands, permanent secretary of the Ministry of Supply, who was a close personal friend of Colonel Devereux. In a memorable and moving speech Sir Archibald described Colonel Devereux as a happy man with great abilities, enormous drive and a warm heart, who had provided in the Fulmer Research Institute something for Great Britain similar to the well-known Battelle and Mellon Institutes of the United States.

After luncheon Lord Waverley (better known to many as Sir John Anderson) spoke on the successful efforts that have been made in Great Britain since the First World War to make good the deficiencies in the national scientific equipment, particularly in the application of science to industry. He recalled that some seven years ago at a conference of the Federation of British Industries on the application of science to industry, he had expressed regret at the absence in Britain of any institution comparable with the Battelle and Mellon Institutes. Despite the amazing increase in scientific effort through the larger industrial units, the universities and the research associations, and other establishments under the ægis of the Department of Scientific and Industrial Research, Lord Waverley still thought there is scope for further effort and expressed the hope that the work of the Fulmer Research Institute would be multiplied many times in other fields.

After paying a personal tribute to Colonel Devereux, Mr. E. A. G. Liddiard, director of research in the Institute, outlined the progress made by the Institute over the first five years, during which the income, now approximately £78,000 a year, has more than trebled and the staff more than doubled. All the income came directly from research contracts, and the Institute received no other income in the form of endowments or government grants. About half the total income was derived from government contracts, and there was a substantial proportion of direct dollar-earning sponsorship from the United States and Canada. There was, however, a steady increase in the volume of work for British industry and he looked for further growth in the future. He considered that the problem most appropriate to a sponsored research institute is one in which research results need considerable expenditure in subsequent development work, and it is essential that those incurring these costs should be assured of a return for their expenditure and for the risk taken by having some form of monopoly in these new developments—preferably in the form of patents covering the original research results. The connexions established in the United States and Canada would, he said, help in the full exploitation of research results obtained for British sponsors.

Sir Frederick Handley Page, on behalf of the guests, thanked the hosts and stressed the opportunities available in the Institute for British industry, particularly for small firms which cannot afford the equipment or staff necessary for the solution of a particular problem.

The laboratories of the Institute were open for inspection and contained exhibits of various items of work completed and in progress. In the Physical Chemistry Section the work of Dr. P. Gross and his colleagues on the refining of metals by reactions involving metal halide vapours was illustrated. This included the determination of heats of formation of metallic halides and the equilibrium and kinetics of various reactions, particularly the reaction $2Al + AlCl_3 \rightleftharpoons 3AlCl$, which forms the basis of the so-called 'catalytic' distillation of aluminium. A small pilot-plant operating this refining process was an important feature. Samples of titanium metal produced in the laboratory by different reactions, details of which were not available, were on show together with samples of titanium trifluoride and of beryllium produced by indirect distillation.

In the Physics, Metallurgy and Engineering Sections, under Dr. A. H. Sully, alloy research included an investigation into the mechanism of age-hardening and work on aluminium–bronze and aluminium–tin bearing metals. The aluminium–copper–cadmium alloys developed by the Institute were claimed to have properties similar to the duralumin-type alloys but to be free from any tendency to age at room temperature and to have exceptionally good hot-working properties. Work on high-temperature materials included an investigation into the ductile-brittle transition of chromium and of metal-ceramic aggregates, and a good deal of interest was shown in the development of low-emissivity protective ceramic coatings for combustion chambers of gas-turbine engines. The Physics Section employs Guinier-type single and double monochromators for studying structural changes in age-hardening alloys; and in the Engineering Section high-temperature fatigue

and creep testing in both tension and compression was in progress, and the use of strain gauges for evaluation of residual stresses and for recording movements in large structures was illustrated. In the Corrosion Section work was in progress on vapour-phase impregnation of iron and steel with silicon, hydrogen embrittlement of steel, and electrodeposition of manganese. Attention was directed to the marked influence of directionality in light-alloy extrusions on resistance to corrosion and stress corrosion.

A large proportion of the equipment and apparatus on view had been constructed in the laboratory workshops, including the pilot plant for aluminium distillation, the vacuum induction and arc-melting furnaces, gas X-ray sets, compression creep machines, furnaces and temperature controllers.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

THE annual report of the Indian Association for the Cultivation of Science for 1951–52* records the completion of the transfer to the Association's new buildings at Jadarpur and the removal of the Department of Organic Chemistry in June 1951, but research work was considerably curtailed by the removal. Research schemes for the X-ray study of coal and for the construction of osmometers for high-polymer research, sanctioned by the Council of Scientific and Industrial Research, were continued, and a new scheme was sanctioned for the construction of a light-scattering apparatus for measuring the molecular weight, size and shape of high polymers.

In the Department of X-rays and Magnetism a systematic investigation has been undertaken into the structures of phenanthrene derivatives, particularly hormones, and N. N. Gupta has been able to show that the nature of the low-angle scattering of X-rays does not depend upon the internal structure of the crystal but only on the size and shape of the particle. R. K. Sen has perfected the method of determining the elastic constants of a crystal by the X-ray diffraction method, and the limitations of the Jahn–Jeller effect have been investigated. Measurement of the conductivity of single crystals of graphite from 80° to 500° K. has been completed, as well as the major equipment for the liquid hydrogen plant.

In the Department of Optics, studies on *p*-dichlorobenzene have shown that crystals cooled once below 0° C. give a different Raman spectrum from crystals not treated thus. New lines in the low-frequency region have been observed in the Raman spectra of *o*-xylene and benzyl bromide, and the ultra-violet absorption spectra of acetophenone, methyl benzoate ethylbenzene and *iso*propylbenzene have been studied in the liquid and solid states, as well as those of the cresols, *o*- and *p*-xylene, benzyl alcohol and benzyl chloride. In the Department of Theoretical Physics, besides work on the meson fields and nuclear scattering, good progress has been made in improving the Born approximation by taking higher terms of a consistent expansion in powers of the constant denoting the strength of the coupling between the field and the particle.

In the Department of Physical Chemistry detailed study has been undertaken of chain transfer in uncatalysed polymerization of styrene methyl methacrylate and methyl acrylate in solvents, and investigations have also been made of the polymerization of methyl methacrylate with hydrogen peroxide in non-aqueous solvents, triphenylmethylcellulose and the solubilization of mixed detergents. In the Department of Inorganic Chemistry, which formally started in July 1951, preliminary investigations were made on co-ordination complexes and ion-exchange methods in inorganic chemistry. Lists of papers published during the year are included, with lists of books and periodicals added to the Library.

* Indian Association for the Cultivation of Science. Annual Report for 1951–52. Pp. ii+40. (From the Association, Calcutta 32; 1952.)

THE CHAYEN PROCESS FOR EXTRACTION OF OILS AND FATS

THE normal process for the extraction of oils and fats from naturally occurring cellular material involves the use of a hot solvent. This process requires steam heating for many hours, resulting in the formation of some undesirable degraded products.

British Glues and Chemicals, Ltd., gave a demonstration of a new process devised by Mr. I. H. Chayen and his associates at their Stratford factory in London on October 28, when they were able to show an entirely new technique. In this process, crushed bones are passed, together with a stream of water, into a modified disintegrator where complete fat rendering is achieved in about one second while the material is in the mill. In this disintegrator, the normal blades had been replaced by beaters arranged to give a clearance of about 4 in. from the mill-casing. With a blade tip-speed of about 12,000 ft. per min., the high-speed impulses given to the water break open the cell-walls of the tissue and enable an easy extraction to follow.

The fat and degreased bone leaving the mill are separated by gravity from the water stream, the fat being skimmed off and purified and the bones passed on for drying, when they are ready for glue making or for incorporation in bone meal.

The importance of this technique lies not only in the fact that it has provided a much improved process for one industry, but also that it has provided a new chemical engineering tool and principle, namely, the use of high-speed impulses to break down mechanical barriers, in this case the cell-walls. The application of high-speed vibrations in the chemical process industries is as yet a largely unexplored field, but this application is already showing a great reward. The degreased bone is ready for glue making in 8 min. and the fats are of much finer quality, since the process is carried out in the cold. The continuous process offers many advantages compared with the old batch one in the form of simplified plant layout and operation, as well as very considerable saving in fuel.

This is an interesting example of a machine produced for one purpose being applied with but small alteration to provide a new mechanism in another industry. British Glues, Ltd., are to be congratulated not only on their discovery of a new principle, but also on the quick way in which they have passed from the pilot plant to the commercial plant, for they now have this process in use in four factories, including one in Canada. They were able to show on a pilot plant the same technique for handling herrings, and the next development may well be in the valuable fish-liver industry.

J. M. COULSON

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Extractability of the Lotmar–Picken Material from Dried Muscle

Bear and Cannan have reported[1] new experiments with muscle exhibiting the so-called Lotmar–Picken[2] X-ray pattern. We, too, recently found a muscle (in our case a *Mytilus* adductor) which gave the pattern, and we have repeated their observation that after extraction with water it gave only the normal α-pattern characteristic of myosin. In addition, our specimen gave a number of new reflexions in the form of almost continuous circles, distinguished from the Lotmar–Picken reflexions in showing scarcely any orientation and in having a more grainy texture; these reflexions, too, disappeared on extraction with water. We attribute them to a new substance which we provisionally call '*X*'. An analysis of the diffraction pattern on these lines is given in the first three columns of the accompanying table.

Whole muscle			Extract
Lotmar–Picken material		Substance '*X*' (continuous circles)	
Equator	First layer line		
0·075 m			
		0·080 m	0·076 m (*X*)
0·086 vw			
	0·105 vw		
0·107 m			0·106 m (LP)
		0·118 s	0·118 m (*X*)
	0·127 m		0·127 m (LP)
0·128 vw			
0·135 w			0·133 w (LP)
	0·140 w		0·139 w (LP)
0·145 m			0·144 w (LP)
		0·161 mw	0·160 m (*X*)
		0·170 mw	0·167 m (*X*)
0·176 w			0·172 w (LP)
	0·178 w		0·178 vs (NaCl)
		0·186 w	0·186 w (*X*)
		0·193 vw	0·189 w (*X*)
		0·221 m	0·219 w (*X*)
		0·229 w	0·226 w (*X*)
			0·251 s (NaCl)

Figures are $\sin\theta/\lambda$ values. Letters indicate intensities as follows: vs = very strong; s = strong; m = moderate; mw = moderately weak; w = weak; vw = very weak. In col. 4, lines attributed to the Lotmar–Picken material are marked 'LP', those attributed to substance '*X*' are marked '*X*', and those attributed to sodium chloride are marked 'NaCl'.

We have obtained some new information by evaporating to dryness the water used to perform the extraction. The residue was seen under the microscope to contain: (*a*) single highly birefringent crystals, and (*b*) soft hygroscopic dendritic deposits which had the appearance of being crystalline but were not detectably birefringent. After thorough drying, the residue gave an X-ray powder pattern which can be analysed into three components: (*a*) strong lines with spacings characteristic of sodium chloride, (*b*) a set of lines the spacings of which are identical with the stronger lines of the Lotmar–Picken pattern, and (*c*) a set of lines corresponding to the continuous circles in the pattern of the original muscle, and presumably due to substance '*X*' (see column 4 of table). This analysis is confirmed by the fact that components (*a*) and (*c*) have a more pronounced graininess than (*b*), and by the observation that on exposure of the specimen to damp air part of the pattern disappears, namely, the lines due to the Lotmar–Picken material, which is presumably deliquescent. We provisionally identify the hygroscopic dendritic deposits with the Lotmar–Picken material and the birefringent crystals with substance '*X*'.

We made two other observations of interest: (*a*) after heating the dried extract to 100° C. for 1½ hr., its X-ray pattern (including the Lotmar–Picken component) was unchanged; and (*b*) a dried water-extract of a 'normal' muscle (exhibiting neither the Lotmar–Picken pattern nor that due to substance '*X*') gave a powder pattern made up of the lines of sodium chloride and the lines characteristic of substance '*X*'; no Lotmar–Picken lines were present.

These observations appear to establish the fact that the Lotmar–Picken material is a soluble, crystalline substance which can be extracted from the muscle by water; and thus, since actomyosin and myosin are most unlikely to be extracted under these conditions, they render it very improbable that the Lotmar–Picken pattern is merely a manifestation of an unusually perfect orientation of myosin. The results argue almost equally strongly against the material being a protein of any sort; the powder pattern of the extract contains no lines with spacings greater than 6·6 A., and the smallest spacings in it which are attributed to the Lotmar–Picken material are of 2·9 A. The powder patterns of all dry protein crystals hitherto examined have included lines of much greater spacing than the former, and have generally faded out before reaching the latter, value. Thus we agree with the view expressed by Bear and Cannan that the Lotmar–Picken substance is probably not a protein, and consider that our results lend additional support to it. The close agreement between one cell dimension of the Lotmar–Picken substance and the axial repeat of myosin would therefore appear to have no significance, except perhaps in the sense that it may encourage the substance to crystallize in the muscle in preferred orientation.

In order to exclude absolutely the possibility that the Lotmar–Picken substance is a protein, we attempted (*a*) to recrystallize the material from a solution which had been heated to 100° C., (*b*) to pass a solution of it through a fine-pored dialysis membrane and then to recrystallize it. These experiments were unsuccessful; but the amount of material available was insufficient to repeat them, and we do not regard the negative results as significant—crystallization of the substance is always a matter of chance, for we found that it did not take place on every occasion when we dried the initial water extract from the muscle. For the same reason we do not consider that our failure to obtain a Lotmar–Picken pattern from the dried extract of a 'normal' muscle proves that the substance is absent from such muscles.

H. E. Huxley
J. C. Kendrew
Medical Research Council Unit for Research on the Molecular Structure of Biological Systems, Cavendish Laboratory, Cambridge. Sept. 30.

[1] Bear, R. S., and Cannan, C. M. M., *Nature*, **168**, 684 (1951).
[2] Lotmar, W., and Picken, L. E. R., *Helv. Chim. Acta*, **25**, 538 (1942).

Is α-Keratin a Coiled Coil?

All recent work[1–6] has confirmed that the structure of the synthetic polypeptide poly-γ-methyl-L-glutamate is based on the α-helix of Pauling and Corey[7]. This structure gives a strong 1·5-A. reflexion on the meridian, and both MacArthur[8] and Perutz[1] have shown that this reflexion also occurs in α-keratin. This suggests forcibly that the α-helix forms an important part of α-keratin.

There are certain difficulties in this idea. One of the main features of α-keratin is the strong reflexion at 5·15 A. on, or very close to, the meridian. The normal α-helix gives strong reflexions on the 5·4-A. layer line, but displaced from the meridian. The difference in spacing is not an insuperable objection, since the α-helix might be more tightly coiled; but it is difficult to see how one could obtain such a narrow meridional arc as is observed for α-keratin, even allowing for our ignorance of the details of the side-chain arrangement.

One way to bring the reflexion nearer to the meridian would be to tilt the α-helix. Since the α-keratin pattern is of wide occurrence, one would expect the tilt to be a constant feature of the structure. The most likely general solution is that the α-helix is bent into a super-helix, or coiled-coil. If the α-helix is twisted into a super-helix with a pitch angle of about 18°, its projection on to the axis would have a periodic variation in density at intervals of $5{\cdot}4 \cos 18° \simeq 5{\cdot}1$ A., and so might explain the observed meridional reflexion which corresponds to this spacing. A pitch angle of 18° could be obtained, for example, from a super-helix of radius 10½ A. (the probable distance between helices) and axial spacing 198 A. (the repeat of African porcupine quill)[6,9].

It is possible to make a rough estimate of the energy required to deform the α-helix by this amount by assuming that (1) the forces preventing small rotations about single bonds are small; (2) the hydrogen bond can be fairly easily deformed by small amounts in direction; (3) the main restoring force comes from the resistance of the hydrogen bonds to deformation in length.

Assuming a force constant for a hydrogen bond of, say, 3×10^4 dynes/cm. (see, for example, Davies[10]), the average energy per residue to deform the α-helix by the amount described above is about one-tenth of a kilo-calorie per residue, which is small. This energy increases roughly as the fourth power of the pitch angle, so that the α-helix can easily be bent through small angles, but resists large deformations.

So far, no reason has been given why the α-helix should be deformed. It seems probable that this is due to the difficulty of fitting together the side-chains of two adjacent α-helices.

I should like to suggest that there may be a general plan underlying the detailed packing of all the various side-chains found in proteins. If the side-chains of the α-helix are thought of schematically as knobs on the surface of a cylinder, then it is found that the pattern on this surface consists of knobs alternating with 'holes', that is, spaces into which the knobs from a neighbouring α-helix could fit. The position of these holes is roughly independent of the exact nature of the surrounding side-chains.

In poly-γ-methyl-L-glutamate, the side-chains are long and flexible and they can reach out towards the nearest hole without deforming the α-helix. In proteins, on the other hand, the side-chains are, on the average, smaller and less flexible, and neighbouring helices are nearer together (10½ A. compared with 12 A. for poly-γ-methyl-L-glutamate). It is therefore not unreasonable to simplify the undoubtedly complicated packing of side-chains into a set of standard rigid knobs fitting into standard holes.

It is impossible to pack such models of the α-helix closely side by side, since a good fit in one place produces a bad fit somewhere else, due to the non-integral nature of the helix. However, it can be shown that by deforming the helices into coiled-coils the knobs can be made to interlock systematically. The energy for deforming the helices could come from the closer fitting together of the side-chains.

The objects of this communication are to stress that the α-helix can be deformed an appreciable amount if the deformation is systematic, to suggest that there may be a general plan underlying the packing together of side-chains, and to show that these two ideas lead to a coiled-coil which may explain some of the data[11] better than a straight α-helix.

F. H. C. Crick

Medical Research Council Unit for Research on the Molecular Structure of Biological Systems,
Cavendish Laboratory,
Cambridge. Oct. 22.

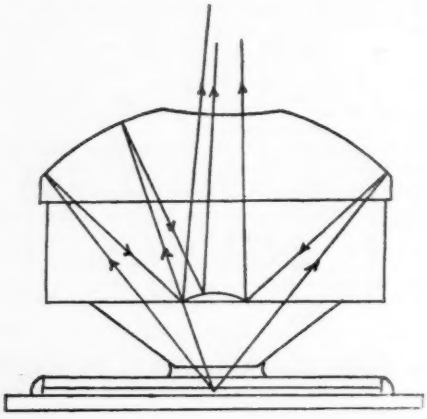
[1] Perutz, M. F., *Nature*, **167**, 1053 (1951).
[2] Cochran, W., and Crick, F. H. C., *Nature*, **169**, 234 (1952).
[3] Bamford, C. H., Brown, L., Elliott, A., Hanby, W. E., and Trotter, I. F., *Nature*, **169**, 357 (1952).
[4] Yakel, H. L., Pauling, L., and Corey, R. B., *Nature*, **169**, 920 (1952).
[5] Fraser, R. D. B., and Price, W. C., *Nature*, **170**, 490 (1952).
[6] Cochran, W., Crick, F. H. C., and Vand, V., *Acta Cryst.*, **5**, 581 (1952).
[7] Pauling, L., and Corey, R. B., *Proc. U.S. Nat. Acad. Sci.*, **37**, 241 (1951).
[8] MacArthur, I., *Nature*, **152**, 38 (1943).
[9] Bear, R. S., *J. Amer. Chem. Soc.*, **65**, 1784 (1943).
[10] Davies, M., Ann. Rep. Chem. Soc., **43**, 1 (1946).
[11] Crick, F. H. C., *Acta Cryst.*, **5**, 381 (1952).

An Easily Used Ultra-Violet Microscope Objective

The ultra-violet microscope is a useful cytochemical tool because it enables one to locate and measure the amounts of absorbing substances in cells (see, for example, Caspersson[1]). It is a considerable advantage if the microscope objective is achromatic throughout the visible and ultra-violet regions of the spectrum; focusing of the microscope in visible light is then simplified, and many wave-lengths may be used simultaneously in order to obtain an absorption curve. Reflecting microscopes are completely achromatic, and hence have been much favoured for cytochemical use (cf. refs. 2 and 3, for example). After several years of use of reflecting objectives, we find they have three main disadvantages: (*a*) the numerical aperture at present possible, $\simeq 0{\cdot}65$, is rather low for many purposes; (*b*) the ultra-violet reflectivity of front-surface mirrors sometimes deteriorates rapidly; (*c*) very exact positioning of the mirrors relative to each other is necessary. If the mirrors are preset during manufacture, dislocation may take place in use, thus necessitating return to the maker; if, however, the objective is adjustable, some users may have trouble in making the adjustments. In this communication we describe a simple objective which has been designed to overcome all these disadvantages.

The numerical aperture of a reflecting objective may be increased by a factor μ when a normal-incidence immersion lens of refractive index μ is placed over the object (cf. ref. 4, for example). The lens and two mirrors of the objective must all be adjusted relative to each other, and, as this is much more difficult than adjusting a simple reflecting objective, such compound objectives are not likely to come into general use. If the normal-incidence immersion lens is enlarged so that it fills the space between the mirrors, the objective is transformed into a solid type[5] (see diagram). The difficulty of finding a suitable means of manu-

facturing such an objective for ultra-violet use has now been overcome. Solid objectives composed of three pieces of glass cemented together with canada balsam have been made[6] for use with visible light. For use with ultra-violet, our objective is made of fused quartz, and, because no really satisfactory ultra-violet transmitting lens cement is known, the parts are optically contacted. Before being permanently contacted, the mirrors are centred by sliding one component of the objective over the other, while viewing a pin-hole test-object.



The mirror-pair consists of two spherical surfaces which would give 0·60 numerical aperture in air. In the solid objective, the refractive index is that of fused quartz and therefore the numerical aperture is $\simeq$ 0·90. The central obstruction of numerical aperture is 35 per cent and the focal length is 1·7 mm.

The objective is made to screw on to any ordinary microscope and to be parfocal with normal objectives. To obtain exact achromatism, it is necessary to use an immersion liquid having the same dispersion as fused quartz. Water almost fulfils this requirement, and the small residual chromatic aberration is compensated by slight refraction at the quartz–air interface where the light leaves the objective. Spherical aberration, due to refraction in the water layer between coverslip and objective, is compensated by suitable separation of the two mirrors. The residual spherical aberration is approximately $\lambda/8$ for 2500 A. The only aberration which limits field-size is coma, and this reaches the Rayleigh limit[7] at a field diameter of $\simeq$ 50 microns for 5400 A. The objective may be designed for use with any thickness of coverslip up to several millimetres, and hence is very suitable for looking through thick windows on pressure-vessels, etc. Coverslips of 0·5 mm. and thicker have the advantage of not cracking when roughly treated.

Objectives of this type have proved very satisfactory during test. There are no adjustments to make, and the objective is no more difficult to use than any normal refracting immersion objective. Achromatism is exact and, when focused for visible light, the objective is also in focus for ultra-violet. Thus really easy ultra-violet microscopy is made possible for any biologist. The mirror surfaces are in contact with the quartz and protected from deterioration due to the atmosphere.

We would like to thank Prof. J. T. Randall for much encouragement during this work.

M. H. F. Wilkins

Medical Research Council
Biophysics Research Unit,
King's College,
London, W.C.2.

K. P. Norris

Wheatstone Physics Laboratory,
King's College,
London, W.C.2.

July 25.

[1] Caspersson, T., *Skand. Arch. Physiol.*, Supp. 8 (1936).
[2] Barer, R., Farad. Soc. Discuss. No. 9 (1950).
[3] Norris, K. P., Seeds, W. E., and Wilkins, M. H. F., *J. Opt. Soc. Amer.*, **41** (1951).
[4] Burch, C. R., *Proc. Phys. Soc.*, **59**, 41 (1947).
[5] Maksutov, D. D., U.S.S.R. Patent No. 40859 (1932).
[6] Bouvers, Trans. London Conference (Optical Instruments), 1950.
[7] Kingslake, R., *Proc. Phys. Soc.*, **61**, 147 (1948).

Magnetostrictive Effect and the Δ-*E* Effect in Nickel

In connexion with the communication in *Nature* of December 1, 1951, p. 963, on sound propagation in ferromagnetic materials, the following experiments may be of interest.

Several authors have remarked upon the change of Young's modulus by the Δ-*E* effect in ferromagnetic materials. Giebe and Blechsmidt[1], for example, excited nickel rods in their resonant modes by their magnetostrictive effect, and detected maxima of vibrations by the same principle. They observed alterations of resonance frequencies when the rods were placed in a magnetic field, and ascribed them to changes in the elasticity due to the Δ-*E* effect. They, and others, do not seem to have noticed that the magnetostrictive effect may modify the changes in resonant frequencies caused by the Δ-*E* effect.

Due to the magnetostrictive effect, there is an interchange of vibrational mechanical energy and magnetic energy, and it can be shown that the ratio between these two forms of energy in a longitudinally vibrating magnetostrictive rod in a magnetic field is expressed by:

$$\frac{W_{\text{m.g.}}}{W_{\text{m.ch.}}} = k^2 = \frac{8\,\mu\varkappa\lambda}{\pi^2(2n+1)^2\,E},$$

where μ is permeability of material, λ is magnetostrictive constant, $\varkappa$ is inverse magnetostrictive constant, E is Young's modulus, $(2n+1)$ is number of vibrational mode, n being an integer, while k is usually called the coupling constant. For even modes, the coupling constant is zero, and it is consequently impossible to excite a rod by the magnetostrictive effect in these modes. If the rod is surrounded by a coil, the frequencies of the modes where the coupling factor has a finite value will, however, depend on the impedance between the terminals of the coil in addition to the elasticity and density of the material.

If the coil is short-circuited, no induction can be set up by the inverse magnetostrictive effect, and consequently no magnetostrictive force is developed. The resonance frequencies of the rod will in this case depend on the density and the elasticity only,

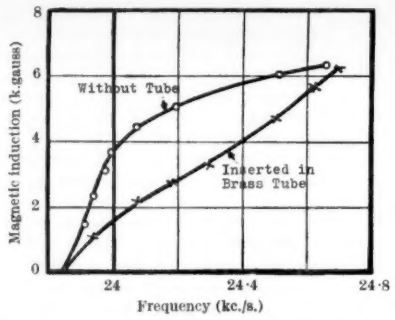


Fig. 1. Deviations of fundamental frequency in nickel rod, with and without surrounding brass tube

the latter modified by the Δ-E effect. If, on the other hand, the rod is vibrating in an odd mode, and the surrounding coil is on open circuit, the magnetostrictive force developed will modify the vibrational behaviour of the rod. This last change in resonant frequencies is due to the magnetostrictive effect only, and it is thus possible to separate the two effects. The following measurements show the magnitudes involved.

A laminated nickel rod, 10 cm. long with a cross-section of 1 cm.^{2}, is longitudinally excited at one end, and the vibrations are detected at the other. In order not to have any reaction from the mechanical generator and detector impedances, a thin wire, approximately 1 cm. long, is soldered on to the nickel rod at either end, and the excitation and detection by two Rochelle salt transducers take place through these wires. Thus no electro-mechanical effect in the rod itself is used for excitation or detection. Permanent magnets are used to produce a polarizing field of varying magnitude in the rod. The rod is then excited in its fundamental mode, in which the coupling according to the formula should be a maximum (10–20 per cent in practical cases). First, the rod is vibrating freely, and the change of resonance frequency versus magnetic field is plotted. Next, the rod is inserted in a short-circuited coil in the form of a brass tube. The change in frequency is again plotted against magnetic field. The results of these two measurements are shown in Fig. 1.

As will be seen, the change of resonant frequency caused by the Δ-E effect is counteracted by the magnetostrictive effect and in a certain range of magnetic field is of the same order. If the rod is excited in its first harmonic frequency, no coupling occurs, and no difference is measured when the rod is inserted in the brass tube. The change in resonance frequency is now entirely due to the Δ-E effect, and Fig. 2 shows the frequency deviations.

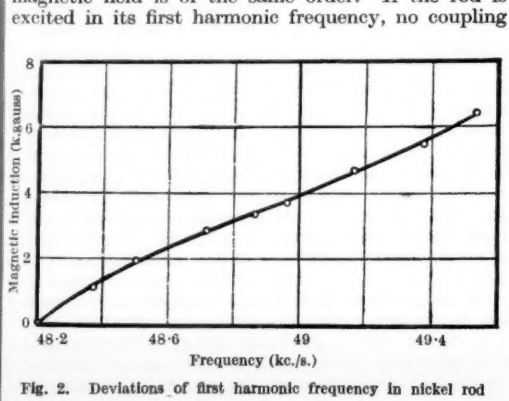


Fig. 2. Deviations of first harmonic frequency in nickel rod

Since the measurements of Giebe and Blechsmidt were carried out at high modes of vibrations, the coupling constant is negligible, and no measurable change would be detected when the impedance between the terminals of the coil is altered. Their results are therefore still valid. For the lower modes, however, the magnetostrictive effect must be taken into account when vibrations are studied.

No measurements were made of the vibrational losses in the rod. It is likely that these will also depend on any induction set up by the magnetostrictive effect, with resulting eddy currents. The present results are part of an investigation into vibrating magnetostrictive systems, and the phenomenon of coupling effects will be presented there in greater detail.

HENRIK NÖDTVEDT

Department A,
Norwegian Defence Research Establishment,
Horten.
March 12.

[1] *Ann. der Phys.*, **11**, No. 8, 58 (1931).

Ultra-Violet Band System of Strontium Oxide (SrO)

THE investigations hitherto made have shown that three band systems belong with certainty to the strontium oxide molecule (SrO); the first of these is situated in the infra-red, the second in the blue and the third in the ultra-violet region. Mahanti made vibrational analyses of the blue and ultra-violet systems[1]. A vibrational and rotational analysis of the infra-red system, a $^1\Sigma - {}^1\Sigma$ transition, was communicated by us in 1949 [2]. This analysis shows that the vibrational frequencies of the lower $^1\Sigma$ state coincide extremely well with those of the lower state of the blue system. Thus for $^1\Sigma$ we found $\omega_e'' = 653{\cdot}4_9$ and $x_e''\omega_e'' = 4{\cdot}0_0$, as compared with $653{\cdot}4_7$ and $4{\cdot}0_2$ for the lower state of the blue system. In our paper we mentioned this agreement and assumed that the infra-red and blue systems have the same lower state. Recently, Budó and Kovács have privately communicated to us that they have made a successful rotational analysis of the blue bands. The transition is $^1\Pi - {}^1\Sigma$, where the lower state is the same as for the infra-red bands.

The ultra-violet band system of strontium oxide, situated between λ 3200 and λ 3700 A., has been investigated with the 21-ft. grating of this institute. The rotational analysis of the 2,0, 1,0 and 0,0 bands shows that the system is a $^1\Sigma - {}^1\Sigma$ transition, where the lower state is the same as that of the blue and infra-red systems. The constants derived for the upper state are

$B_0' \sim 0{\cdot}272$ cm.$^{-1}$ $\quad B_2' \sim 0{\cdot}269$
$B_1' \sim 0{\cdot}271$ cm.$^{-1}$ $\quad D' \sim 0{\cdot}3 \times 10^{-4}$

No upper vibrational constants have yet been calculated. The bands contain several perturbations in the upper state.

From measurements of the band-heads (R-heads) of the ultra-violet system, Mahanti has calculated for the lower state of this system $\omega'' = 679{\cdot}13$ and $x''\omega'' = 9{\cdot}13$. At first glance these values do not suggest that the lower state is the same as that for the other systems. The deviations from these values

and those obtained from origins are not greater, however, than may be expected.

A more detailed paper on the ultra-violet bands will appear in *Arkiv för Fysik*.

Gunnar Almkvist
Albin Lagerqvist

Physics Department,
University of Stockholm.
April 24.

[1] Mahanti, P. C., *Phys. Rev.*, **42**, 609 (1931).
[2] Almkvist, G., and Lagerqvist, A., *Arkiv för Fysik*, **1**, 477 (1949).

Spectrum of the Compton Radiation from Solids

The spectrum of the Compton radiation from *free* atoms has been calculated[1] and was found to consist of a band with a sharp limit towards short wave-lengths. At the same time some 'electronic Raman lines' are supposed to exist between the limit and the line of the primary radiation. In the case of *solids*, this picture should be modified because the discrete energy-levels are replaced by energy bands. The form of the spectrum will depend on the density distribution of states in the highest occupied energy-zone and in the free zone above it. The sharp limit and the electronic Raman lines will be replaced by broad bands, possibly with a structure. If the highest occupied zone is filled and there is a forbidden zone above it—as in the case of insulators—the broad Compton band should show a limit towards short wave-lengths. The energy shift between this limit and the primary line will be equal to the breadth of the forbidden zone. Although most experiments on Compton scattering have been carried out on solids, such a structure has not yet been observed because of the short wave-lengths used. In the following an account is given of experiments showing the above effect.

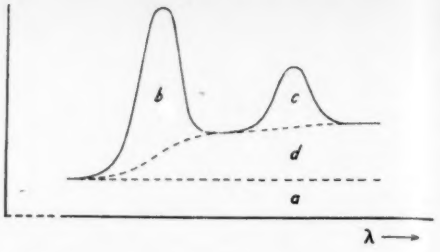
Unfiltered copper radiation is scattered on beryllium and carbon at angles between 17° and 45°. The scattered radiation is collected in a bent crystal spectrometer and is then investigated spectroscopically with a Geiger–Müller counter moved along the Rowland circle. The form of a typical spectrum obtained is shown in the accompanying graph. The surface under the curve can be divided into the following areas: (*a*) background, (*b*) line α_1, (*c*) line α_2, and (*d*) the Compton band.

(*a*) *Beryllium*. Experiments were carried out at angles of 20·5°, 25·5°, 30°, 35° and 40°. In all cases the Compton band starts near the primary line, showing that no limit towards short wave-lengths exists. Also in no position of the spectrum does it show an appreciable maximum.

(*b*) *Graphite*. The Compton band at 17° was found to have the same properties as that of beryllium.

(*c*) *Diamond*. At angles of 17° and 30° the Compton band has no appreciable intensity near the primary line. It could only be measured at longer wave-lengths than the α_2-line. At an angle of 35° its intensity is sufficient to show that it starts between the lines α_1 and α_2 at a position corresponding to a shift of 7·5 eV. from the primary line. A similar hump can be observed at a position of the spectrum that corresponds to a shift of 7·5 eV. from the α_2-line.

The spectra obtained agree fully with the current theory of solids. The electrical conductivity of beryllium leaves no possibility for the existence of a forbidden zone. Also, the fact that the absorption edge coincides with the high-energy limit of the emission line proves that this view is correct.



A graphite single crystal irradiated in such a way that the incident and the scattered radiation are contained in the basal plane should at $T = 0$ give a Compton band with a zero intensity at zero shift and with increasing intensity as the shift increases[2]. The present experiment does not show this behaviour because $T \neq 0$ and because the graphite was polycrystalline.

Diamond has a fully occupied zone that is separated from the next free zone[3] by a forbidden zone of about 7 eV. This has been found from absorption experiments in the ultra-violet. The present experiments also indicate the existence of such a forbidden zone.

A detailed report on the above experiments will appear in the *Arkiv för Fysik*.

Kessar Alexopoulos
Gösta Brogren

Fysiska Institutionen,
Uppsala.
May 21.

[1] Sommerfeld, A., *Ann. der Phys.*, **29**, 715 (1937). Franz, W., *ibid.*, **29**, 721 (1937).
[2] Coulson, C. A., *Nature*, **159**, 265 (1947).
[3] Kimball, G., *J. Chem. Phys.*, **3**, 560 (1935).

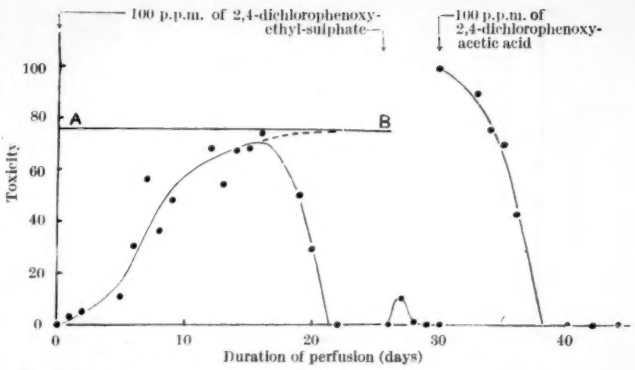
Fate of Sodium 2,4-Dichlorophenoxy-ethyl-sulphate in the Soil

Sodium 2,4-dichlorophenoxy-ethyl-sulphate, a chemical of low intrinsic phytotoxicity, can be sprayed in relatively concentrated aqueous solutions on to plants normally sensitive to the hormone herbicides, without serious damage to them; but when it comes into contact with the soil, a high phytotoxicity is generated, sufficient to give satisfactory control of weed-seed germination in the surface layers of the soil[1]. The toxic compound arising from it has been assumed to be 2,4-dichlorophenoxy-acetic acid (2,4-D).

To check this assumption, the behaviour of sodium 2,4-dichlorophenoxy-ethyl-sulphate in soil has been followed using the perfusion technique described for previous investigations on the herbicides 2,4-D and MCPA (2-methyl-4-chloro-phenoxyacetic acid)[2]. Solutions of 100 p.p.m. of the substance have been perfused continuously through garden loam and the changes in phytotoxicity of the perfusate followed by the cress root-growth assay technique[2]. The results of a typical experiment are shown in the graph, where toxicity is expressed in 2,4-dichlorophenoxyacetic acid equivalents (p.p.m.). Toxicity is generated slowly at first; but the rate increases up to about the eighth day, suggesting the proliferation of an organism adapted to bring about the interconversion. Later, the toxicity curve flattens out, probably due

to the exhaustion of the dichlorophenoxy-ethyl-sulphate substrate, and becomes asymptotic to the line *AB*, corresponding to a concentration of 75·5 p.p.m. 2,4-dichlorophenoxyacetic acid, which is the theoretical concentration that would be generated in the perfusate by the complete conversion of the dichlorophenoxy-ethyl-sulphate.

After sixteen days, a rapid fall sets in and all toxicity is lost after twenty days. When 2,4-dichlorophenoxyacetic acid itself is perfused through fresh soil, no change in toxicity is noted for about fifteen days, after which a similar rapid detoxication occurs[2]. These almost identical time-relationships for the two detoxications is a strong indication that the dichlorophenoxy-ethyl-sulphate generates 2,4-dichlorophenoxy-acetic acid. During initial perfusion with dichlorophenoxy-ethyl-sulphate the accumulated 2,4-dichlorophenoxyacetic acid would induce the growth of a population of organisms adapted for its breakdown, giving, therefore, a lag phase characteristic of that organism[2].



Time course of toxicity in soil solutions on perfusing with 100 p.p.m. sodium 2,4-dichlorophenoxy-ethyl-sulphate (two successive perfusions) and then with 100 p.p.m. 2,4-dichlorophenoxyacetic acid

The subsequent perfusion of fresh sodium 2,4-dichlorophenoxy-ethyl-sulphate solution (at twenty-six days in this experiment) fails to generate a similar high toxicity. In the first day only a small activity develops, but this disappears in the next twenty-four hours. Obviously the detoxicating organism is capable of destroying all the toxic compound as fast as it is produced. This indicates that the use of dichlorophenoxy-ethyl-sulphate may give satisfactory weed control only with the first application, and that the efficacy of successive treatments after short time intervals may be reduced to a very low level by the development of a population of detoxicating soil micro-organisms.

A solution of 100 p.p.m. 2,4-dichlorophenoxyacetic acid perfused at thirty days was afterwards detoxicated with only a slight lag of about two days, and the maximum rate of disappearance of toxicity was of the same order as that for the first perfusion with dichlorophenoxy-ethyl-sulphate. This means that the detoxicating soil organisms are definitely adapted to 2,4-dichlorophenoxyacetic acid, and this is further indication that the latter was itself the adapting molecule.

Lastly, samples of perfusate were taken during the first dichlorophenoxy-ethyl-sulphate perfusion and run on a one-way paper-partition chromatogram using propanol – ammonia as the developing solvent. The position of the spots of the phytotoxic compound were afterwards determined by sectioning the paper strip and subjecting these sections to a sensitive biological assay. Full details of this assay will be published later. The R_F value of the toxic compound generated from sodium 2,4-dichlorophenoxy-ethyl-sulphate was 0·7, which is identical with that given by 2,4-dichlorophenoxyacetic acid samples run from a fresh solution and also after prior perfusions through soil. Samples of dichlorophenoxy-ethyl-sulphate perfusate have been analysed during the whole of the perfusion period before detoxication sets in, and there is no indication that more than one toxic compound is generated.

There seems little doubt, therefore, that the toxic molecule is indeed 2,4-dichlorophenoxyacetic acid, and that it afterwards behaves in the same way as if added directly to the soil.

I wish to express my thanks to Dr. W. G. Templeman, of Imperial Chemical Industries, Ltd., for supplying me with the sodium 2,4-dichlorophenoxy-ethyl-sulphate, and also to Miss R. F. Thresh, of this Department, for carrying out the chromatogram analyses and the associated biological assays.

L. J. Audus

Botany Department,
Bedford College
(University of London),
Regent's Park,
London, N.W.1.

[1] King, L. J., Lambrecht, J. A., and Finn, T. P., Contrib. Boyce Thompson Inst., **16**, (4), 191 (1950).
[2] Audus, L. J., *Plant and Soil*, **3**, (2), 170 (1951).

β-Oxidation of ω-Phenoxyalkylcarboxylic Acids in the Flax Plant

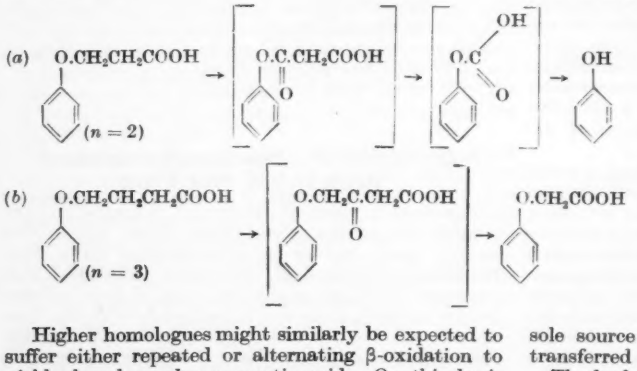
Since the classical work of Knoop[1] on the β-oxidation of long-chain fatty acids within the animal body, numerous investigations have been carried out in this field. It is now established that such an oxidative mechanism does, in fact, operate in the animal[2]. On the other hand, evidence that β-oxidation occurs within plant tissue is lacking. Synerholm and Zimmerman[3], however, studying a homologous series of seven ω-(2 : 4-dichlorophenoxy)-alkylcarboxylic acids, found an alternation in growth-regulating activity to occur with increasing length of side-chain. The results were consistent with the view that degradation of these acids by β-oxidation was taking place within the plant.

We have synthesized the series of ω-phenoxyalkyl-carboxylic acids ($C_6H_5O(CH_2)_nCOOH$) from $n = 1$ to $n = 10$ and have studied their influence on plant growth. These biological results will be discussed elsewhere. Breakdown of the acids within growing flax seedlings has also been investigated, the whole series being included in each of five experiments. The solution of the ammonium salt of the acid ($2{\cdot}5 \times 10^{-3}$ *M*) was supplied through the roots to a uniform group of 200 seedlings during ten days growth in the glasshouse. The seedlings were then washed, macerated with water and the acidified mixture steam-distilled under standardized conditions. Phenol was estimated colorimetrically in the steam

Phenol recovered from 200 flax seedlings following absorption of ω-phenoxyalkylcarboxylic acids ($C_6H_5O(CH_2)_nCOOH$) through the roots (average results from five experiments)

distillate[4]. No phenol was obtained from the compounds in absence of plant material following such treatment. Within the plant, acids with an even number of side-chain methylene groups gave rise to considerable amounts of phenol. No evidence is available on the form in which this phenol existed in the plant. From those acids in which n is an odd number only traces of phenol were obtained.

The results (see histogram) are consistent with the view that β-oxidation of the side-chain takes place as follows[3,5]:



Higher homologues might similarly be expected to suffer either repeated or alternating β-oxidation to yield phenol or phenoxyacetic acid. On this basis 9-phenoxynonane-1-carboxylic acid ($n = 9$) was not expected to yield phenol. In fact, in all five separate experiments appreciable phenol was produced. This apparently anomalous result, however, is of interest in connexion with certain animal metabolism studies, for example, the breakdown of β-hydroxyaliphatic acids in pigeon muscle[6], and of saturated triglycerides in human metabolism[7]. In both these investigations the compounds corresponding in chain-length to our phenoxy acids with $n = 8$, 9 and 10 showed different behaviour from the other homologues. These differences were ascribed to the occurrence of ω-oxidation[6,7], a mechanism which on spatial considerations would appear to be restricted to acids of these chain-lengths[3].

This chemical method for investigating degradation of phenoxy acids within living plant tissue is now being extended to the study of fungi and bacteria. In addition, further work involving enzyme preparations from the flax plant is in progress.

C. H. Fawcett
J. M. A. Ingram
R. L. Wain

Wye College
(University of London),
Nr. Ashford, Kent.
May 20.

[1] Knoop, F., *Hofmeister's Beitr.*, **6**, 150 (1904).
[2] Breusch, F. L., "Advances in Enzymology", **8**, 343 (1948).
[3] Synerholm, M. E., and Zimmerman, P. W., Contrib. Boyce Thomp. Inst., **14**, 369 (1947).
[4] Porteous, J. W., and Williams, R. T., *Biochem. J.*, **44**, 46 (1949).
[5] Fawcett, C. H., Thesis, London (1951).
[6] Breusch, F. L., and Tulus, R., *Enzymologia*, **11**, 352 (1944).
[7] Verkade, P. E., and Lee, J. van der, *Biochem. J.*, **28**, 31 (1934).

Hydrolysis and Metabolism by Soil Bacteria of Benzoyl Derivatives of D- and L-Forms of some Amino-acids

In a previous communication[1] we have reported that two strains (*KT* 83 and *KT* 82) of soil bacteria were able to utilize benzoyl-D-phenylalanine as well as benzoyl-L-phenylalanine as a sole source of carbon and nitrogen, whereas one strain (*KT* 84) could utilize the L-form but not the D-form, and that benzoyl-D-phenylalanine was hydrolysed by a suspension of either *KT* 83 or *KT* 82, but not by *KT* 84.

We have now studied the hydrolysis and metabolism by *KT* 83 and *KT* 84 of benzoyl derivatives of D- and L-isomers of six amino-acids, phenylalanine, tyrosine, alanine, aminobutyric acid, *p*-methoxyphenylalanine and 3,4-methylendioxyphenylalanine. At the outset we confirmed that *KT* 84 grew luxuriantly at 25° C. in the synthetic medium containing each one of the benzoyl derivatives of racemic forms of the above six amino-acids as a sole source of carbon and nitrogen, and could be transferred more than three times in succession.

The hydrolytic activity of the bacterial suspension *KT* 84 was then tested upon benzoyl derivatives of the racemic forms of six amino-acids in the presence of toluene, at 37° C. and at *p*H 7·0–7·2 for five days. We were able to isolate benzoic acid (95–82 per cent, calculated from the L-forms), benzoyl-D-amino-acids (90–80 per cent) and L-amino-acids, which were identified as the benzoyl compounds.

The properties of the compounds obtained in this way were as follow:

Benzoic acid, m.p. 119°–120°		
Benzoyl-D-phenylalanine, m.p. 139°–140°	$[\alpha]_D^{18}$ = − 14·9° (5·2 per cent in sodium hydroxide)	
Benzoyl-L-phenylalanine, m.p. 139°–140°	$[\alpha]_D^{18}$ = + 14·8° (5·1 " " " " ")	
Benzoyl-D-tyrosine, m.p. 162°–163°	$[\alpha]_D^{16}$ = − 36·2° (1·6 " " " " ")	
Benzoyl-L-tyrosine, m.p. 162°–163°	$[\alpha]_D^{19}$ = + 35·9° (1·5 " " " " ")	
Benzoyl-D-alanine, m.p. 147°–148°	$[\alpha]_D^{21}$ = − 37·2° (2·5 " " " " ")	
Benzoyl-L-alanine, m.p. 146°–147°	$[\alpha]_D^{21}$ = + 37·0° (2·5 " " " " ")	
Benzoyl-D-aminobutyric acid, m.p. 110°–111°	$[\alpha]_D^{15}$ = − 30·2° (1·2 " " " " ")	
Benzoyl-L-aminobutyric acid, m.p. 110°–111°	$[\alpha]_D^{19}$ = + 30·4° (3·2 " " " " ")	
Benzoyl-D-*p*-methoxyphenylalanine, m.p. 135°–136°	$[\alpha]_D^{16}$ = − 7·0° (5·0 " " " " ")	
Benzoyl-L-*p*-methoxyphenylalanine, m.p. 135°–136°	$[\alpha]_D^{8}$ = + 6·9° (5·0 " " " " ")	
Benzoyl-D-3,4-methylendioxyphenylalanine, m.p. 126°–127°	$[\alpha]_D^{18}$ = + 9·8° (1·4 " " " " ")	
Benzoyl-L-3,4-methylendioxyphenylalanine, m.p. 126°–127°	$[\alpha]_D^{19}$ = − 9·7° (1·4 " " " " ")	

It was further ascertained that none of six benzoyl D-amino-acids was hydrolysed by the suspension of *KT* 84 even after seven days. In a cultivation experiment, none of six benzoyl D-amino-acids but all six benzoyl L-amino-acids were utilized by *KT* 84.

KT 83 had the power to utilize in cultivation and to hydrolyse in the form of bacterial suspension six benzoyl-D-amino-acids as well as six benzoyl-L-amino-acids. Previously it was reported that the bacterial suspension *KT* 83 had hydrolysed only 34 per cent of benzoyl-D-phenylalanine at 37° during seven days[1]; but, in the present work, we observed that 87–85 per cent, calculated from the benzoic acid isolated, of six benzoyl D-amino-acids was hydrolysed within three days. It seemed that *KT* 83 had become adapted to the substrate during the successive cultivations.

YUKIO KAMEDA
ETSUKO TOYOURA
HIROSHI YAMAZOE
YUKIO KIMURA
YOSHIRO YASUDA

Laboratory of Biochemistry,
Faculty of Pharmacy,
Kanazawa University,
Japan.
May 8.

[1] Kameda, Y., Toyoura, E., Kimura, Y., and Yamazoe, H., *Nature*, [169, 1016 (1952)].

Soil Bacteria and Chlamydospore Formation in *Fusarium solani*

CHLAMYDOSPORE formation and their numbers have been found to vary between species in the genus *Fusarium* and have been widely used in systematic nomenclature as a key character[1,2]. Nevertheless, no positive evidence has so far been adduced on the causes inducing the formation of this morphological structure, although it is generally presumed to be the result of unfavourable growth conditions. Control of soil-borne infection of various crop plants has been achieved by the addition of specific antibiotics[3] or by suspensions of soil bacteria and their toxins[4–6]. These observations, together with the more recent discovery[7] of plants absorbing antibiotics produced by soil micro-organisms, suggested the probability of this factor stimulating chlamydospore formation in *Fusarium* mycelia.

Two pure cultures of soil bacteria isolated from the black cotton soils of southern India, *B* I (not yet finally identified) and *B* II (*Bacillus licheniformis*), were employed in preliminary trials. Bacterial cells suspended in sterile distilled water were quantitatively added in seeding 2 per cent agar medium poured in Petri dishes. The bacterial-seeded and unseeded media (control) in Petri dishes were inoculated with a soil isolate of *Fusarium solani* and incubated for four days at 27°–29° C. Chlamydospore numbers in unit area were determined microscopically from uniform cork borer disks of the media cut in the centre of the colony surrounding the point of *Fusarium* inoculation (see table).

Both the bacterial isolates stimulated chlamydospore formation significantly. While 0·384 million cells of *B* I increased the number of chlamydospores over the control from 5 to 13, the corresponding figures in the case of *B* II were from 5 to 109. Number of chlamydospores from *A* to *B* to *C* to *D* to *E*, *seriatim*, increased approximately two-fold with each increase in the concentration of *B* I cells.

Series	*B* I		*B* II	
	No. of bacterial cells added (millions)	No. of chlamydospores formed per unit area	No. of bacterial cells added (millions)	No. of chlamydospores formed per unit area
A	0·128	8	0·384	109
B	0·384	13	1·152	110
C	0·640	22	1·926	111
D	0·896	41	2·688	130
E	1·152	86	3·456	132
F	1·280	102	3·840	132
Control	—	5	—	5
	C.D. at 1 per cent level = 6·4		C.D. at 1 per cent level = 9·0.	
	F E D C B A CONT.		*F E D C B A* CONT.	

As to the *modus operandi* of bacterial stimulation of chlamydospore formation, it is probably due to antibiotics produced by the bacteria *in situ*, since in preliminary experiments even the addition of bacterial metabolites induced such stimulation in *F. solani*. These observations are of considerable interest, as many *Fusaria* are known to survive in soils under adverse conditions of microbial antagonism[8,9].

I thank Prof. T. S. Sadasivan for his suggestions and interest throughout the course of this work, and Dr. E. W. McCloy, of the London School of Hygiene and Tropical Medicine, for the identification of the bacterial culture.

C. S. VENKAT RAM

University Botany Laboratory,
Madras 5.
March 30.

[1] Sherbakoff, C. D., *Phytopath.*, **37**, Abstract (1947).
[2] Wollenweber, H. W., and Reinking, O. A., "Die Fusarien" (1935).
[3] Arnstein, H. R. V., *et al.*, *J. Gen. Microbiol.*, **2**, 111 (1947).
[4] Sadasivan, T. S., *Proc. Ind. Acad. Sci.*, **33**, 135 (1951).
[5] Slykhuis, J. T., *Canad. J. Res.*, (C), **25**, 155 (1947).
[6] Vasudeva, R. S., and Roy, T. C., *Ann. App. Biol.*, **37**, 169 (1950).
[7] Brian, P. W., *et al.*, *Nature*, **167**, 347 (1951).
[8] Sadasivan, T. S., *Ann. App. Biol.*, **23**, 497 (1939).
[9] Zachariah, A. T., doctoral thesis Madras Univ. (1949).

Growth-Factor Requirements of *Pellicularia koleroga* Cooke in Pure Culture

A PURE culture (isolate 1) of *Pellicularia koleroga*[1] (*Corticium koleroga*) was isolated from the basidiospores found on *Coffea arabica* leaves, following well-known methods[2]. The fungus grew well on a number of agar media containing fresh extracts of potato, onion, carrot, oat, bean and malt, whereas its growth was very poor on a dextrose nitrate medium. However, when small quantities of malt, yeast, coffee leaf or fungal mat extracts were added to the dextrose nitrate medium, the fungus made good growth. A culture of this fungus obtained from the Centraalbureau voor Schimmelcultures, Baarn, Holland, also behaved similarly, and its growth was even slower. It was therefore felt that *Pellicularia koleroga* may have certain growth-factor requirements.

That many of the filamentous fungi show growth-factor deficiencies when synthetic media are used is well known[3,4]. Pure growth-factors were added singly to flasks containing 20 ml. synthetic medium prepared from analytical quality salts (composition: 2 gm. KNO_3, 1 gm. KH_2PO_4, 0·5 gm. $MgSO_4.7H_2O$, 20 gm. glucose or sucrose, 1 litre glass-distilled water).

The *p*H value of this medium was 5·2; all cultures were incubated for 30 days at 20°–22° C. Both with glucose and with sucrose, a negligible amount of growth was made in the control medium to which no growth-factor was added, and in the media receiving any one of the following: riboflavine, pyridoxine hydrochloride, *d*-pantothenic acid (as calcium salt), nicotinic acid, and *p*-aminobenzoic acid at rates of 250 μgm. per litre; inositol at a rate of 100 mgm. per litre. The responses to thiamine hydrochloride and to biotin, which varied with the carbohydrate source, are shown in the accompanying table.

Mycelial Dry Weights (mgm.)

	With glucose	With sucrose
Thiamine hydrochloride (250 μgm. per litre)	129·5	89·9
(+) Biotin (100 μgm. per litre)	negligible	59·7
Control (no growth-factor added)	negligible	negligible

A further investigation of these interesting effects of thiamine and biotin is in progress.

I am indebted to Prof. T. S. Sadasivan, for his help and guidance during the course of this work.

K. T. Mathew

University Botany Laboratory,
Madras 5.
March 31.

[1] Rogers, D. P., *Farlowia*, **1**, No. 1 (1943).
[2] Coleman, L. C., Venkata Rao, M. K., and Narasimhan, M. J., Mysore State Dept. Agric., Mycol. Ser., Bull. 5 (1923).
[3] Robbins, W. J., and Kavanagh, V., *Bot. Rev.*, **8** (1942).
[4] Schopfer, W. H., "Plants and Vitamins" (Chronica Botanica Co., Waltham, Mass., 1943).

Influence of Mineral Nutrition on the Resin Content of the Hop Cone

The influence of manuring on the resin content of the hop cone (strobile) has been the subject of a number of investigations. Doerell[1] concluded from German and Czecho-Slovakian experiments that the resin content rose when potassium and phosphorus were applied in excess of nitrogen, and more recently Zattler[2], in Germany, has stated that phosphorus has a beneficial effect on resin content, but that excess of potash, and especially of nitrogen, depresses the resins. The depressing effect of nitrogen has also been reported by Keller and Magee[3] in the United States.

Contrary results have, however, been found by other workers. In the Poperinghe district of Belgium, a detailed study of the chemical and physical composition of the soil and its influence on the resin content of the hop was made by de Koker, Verbelen and Van der Velde[4]; no relationship could be found. In England, Burgess[5], in a manurial trial carried out over a period of years, studied the effect of complete omission of nitrogen, phosphorus and potassium on hop growth. The yield of cones was markedly depressed by these treatments, and, in the case of nitrogen and potassium, the plants developed characteristic deficiency symptoms; samples of hop cones were taken from each treatment and from a plot receiving complete nitrogen–phosphorus–potassium manuring, but on analysis no appreciable difference in resin content was found which could be attributed to the manurial treatments.

In view of these conflicting results, and as part of a programme devoted to the study of the mineral nutrition of the hop now being carried out at Wye, the question is being further investigated.

In 1951, samples of cones were taken from a long-term factorial manuring experiment primarily designed to study the effect of different levels of nitrogen, phosphorus, potassium and magnesium on the yield of cones of the Fuggle hop. The samples were analysed for total soft resins and α-acid, and the β-fraction determined by difference. The results obtained are shown in the accompanying table, the figures representing the mean values for totals of sixteen plots.

Treatment		Resin content as per cent of oven-dry cones		
		α-Acid	β-Fraction	Total soft resins
Nitrogen (as N)	300 lb. per acre	4·06	7·57	11·63
	400 " " "	4·09	7·46	11·54
Phosphorus (as P_2O_5)	200 " " "	4·15	7·55	11·70
	500 " " "	4·00	7·48	11·47
Potassium (as K_2O)	200 " " "	4·02	7·36	11·37
	400 " " "	4·13	7·67	11·80
Magnesium (as Mg)	28 " " "	4·01	7·40	11·43
	83 " " "	4·14	7·63	11·76

As will be seen from the table, the levels of nitrogen, phosphorus, potassium and magnesium applied to the plots differed widely; but the effect on resin content was negligible, none of the differences found being statistically significant.

Sand-culture experiments using the Fuggle variety were also carried out at Wye in 1951 to investigate the effect of nitrogen, phosphorus and potassium nutrition on resin production. As this was a pilot experiment, the nutrient-levels chosen were necessarily somewhat arbitrary, but they were selected to give wide differences in the levels of nitrogen, phosphorus and potassium as follows:

Nitrogen	50 p.p.m. and 500 p.p.m.
Phosphorus	10 p.p.m. and 200 p.p.m.
Potassium	25 p.p.m. and 500 p.p.m.

Under the low-potassium treatment, the hop plants produced no cones; but samples were taken from all the other treatments and these showed no appreciable differences in resin content with the exception of the high-phosphorus treatment; this produced cones which were low in resins, but which were abnormal in that they were small and underdeveloped.

To date, these experiments lend support to the earlier findings of Burgess and the Belgian workers that mineral nutrition has little influence on resin-production in the hop cone.

The experiments are being continued and will be reported in full elsewhere at a later date.

F. C. Thompson
A. H. Burgess

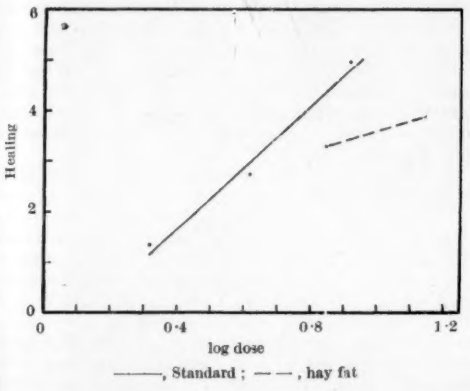
Department of Hop Research,
Wye College
(University of London),
Nr. Ashford, Kent.
May 1.

[1] Doerell, E. G., "Die Düngung des Hopfens" (Verlag der Wissenschaftlichen Anstalten für Brauindustrie, Prag, 1933).
[2] Zattler, F., *Brauwissenschaft*, N. 12, 177 (1949). (Abstract in *Wallerstein Lab. Comm.*, **13**, 160 (1950).)
[3] Keller, K. R., and Magee, R. A., *Agron. J.*, **44**, 93 (1952).
[4] de Koker, Verbelen and Van der Velde, *Petit J. Brass.*, **39**, 1417 (1931).
[5] Burgess, A. H., *J. Inst. Brew.*, **33**, 138 (1935).

A Factor in Hay inhibiting the Action of Vitamin D

During our investigation on the vitamin D content of hay in Holland, started in 1950, the impression soon arose that hay contains a factor antagonistic to vitamin D.

It was noticed repeatedly that the regression line, indicating the relation between recovery of rachitic rats and the logarithm of the dose of pure vitamin D, showed a higher—sometimes a substantially higher—regression coefficient than the analogous regression line of the fat from hay under examination (see graph). Doubling the dose of hay fat scarcely ever resulted in the recovery which would be anticipated from the initial dose applied.



———, Standard ; — — , hay fat

Statistical calculation showed that the difference in slope of the lines for each individual experiment was not at all significant; in other words, the regression lines could be considered as running parallel.

As more experimental results became available, we were able to find out whether the two groups of regression coefficients indicated real differences. The results are summarized in Table 1. Only those experimental results have been inserted for which it could be assumed that they were on the straight part of the sigmoid curve indicating the relation between the log-dose and recovery.

Table 1

Exp. No.	Regression coefficient		Difference
	Standard	Hay fat	
1	3·87	1·46	− 2·41
6	6·12	1·99	− 4·13
7	5·31	2·99	− 2·32
	5·31	2·99	− 2·32
8	6·10	4·32	− 1·78
11	4·07	3·16	− 0·91
13	6·56	3·46	− 3·10
	6·56	7·65	+ 1·09
14	5·27	2·09	− 3·18

Mean difference, $\bar{x} = 2{\cdot}12$; standard error, $s_{\bar{x}} = 0{\cdot}50$; t(exp.) = $2{\cdot}12/0{\cdot}50 = 4{\cdot}240$; t(theor.) ($P = 0{\cdot}01$) = 3·355.

It was evident from this that there was a highly significant difference between the regression coefficients of the standard and the hay-fat regression lines.

To prove in another way also that hay contains an anti-vitamin D substance, we have, from May to October 1951, added to hay fat definite quantities of vitamin D and investigated whether these could be recovered. We have noticed in the meantime that we have followed thereby the same course as Grant[1], and we arrived at exactly the same results.

During a fortnight, a few groups of eleven rats each were fed daily a quantity of hay fat, corresponding to 0·6 gm. of hay, contained in 0·2 c.c. of arachis oil. Other groups were given additionally 0·3 I.U. of vitamin D in the hay-fat solution. We were never able to recover the extra quantity of vitamin D supplied in that way. The quantity lost varied from 20 to 50 per cent. Neither was it recovered if the vitamin D and the hay fat were given separately at an interval of 8 hr., by supplying the vitamin D in the morning and the hay fat at night, and allowing the rats to take food during the day (Table 2). The inhibiting action of hay, therefore, cannot be attributed to a decreased absorption or destruction of vitamin D in the digestive tract, but is effective in the body after resorption from the gut.

Table 2

Exp. No.	Daily dose	X-ray healing	Vitamin D based on healing effect	Deficit (per cent)
10*A*	Fat of 0·6 gm. hay in 0·2 c.c. oil	1·56	1·98 I.U.	
	Fat of 0·6 gm. hay with 0·3 I.U. vit. D in 0·2 c.c.	3·32	5·28 ,,	21
10*B*	Fat of 0·6 gm. hay in 0·2 c.c. oil	2·80	3·96 ,,	
	Fat of 0·6 gm. hay with 0·3 I.U. vit. D in 0·2 c.c.	3·82	7·04 ,,	27
16	Hay fat in 0·2 c.c. oil	2·63	4·56 ,,	
	Hay fat with 0·4 I.U. vit. D given together	3·96	8·21 ,,	35
	Hay fat and 0·4 I.U. vit. D given separately	3·67	7·21 ,,	53

The antivitamin D factor (which we assume to be the same as that found by Grant) must be rather stable, as it has been found in hay as well as in dried grass. Furthermore, it is not only soluble in ether but also in petroleum-ether (b.p. 40–60° C.). The factor is resistant to saponification, as we could demonstrate it in the unsaponifiable fraction of hay fat.

The discovery of this factor inhibiting vitamin D may offer a partial explanation of the fact that some authors have not been able to find any vitamin D in fresh and artificially dried grass, whereas others could, and also of the unexplainable large differences in the vitamin D content sometimes noticeable in hay.

It is too early yet to offer an opinion on the importance of the anti-vitamin D factor as regards practical animal feeding. Our experiments with rats show in any event that the action of vitamin D can be diminished by 20–50 per cent by the factor. It is not at all certain that with cattle, for example, the effect will be exactly the same. That the existence of the factor can raise difficulties in practical feeding is clear from the observations on sheep recorded by Fitch[2] and Ewer[3] in New Zealand.

J. Weits

Laboratory of Animal Physiology,
Agricultural University College,
Wageningen.
April 28.

[1] Grant, A. B., *Nature*, **168**, 789 (1951).
[2] Fitch, L. W. N., *Aust. Vet. J.*, **19**, 2 (1943).
[3] Ewer, T. K., *Brit. J. Nutr.*, **2**, 406 (1948); *Nature*, **166**, 732 (1950).

Corticium praticola Kotila ; an Interesting Basidiomycete occurring in England

The usual forms of *Rhizoctonia* when grown on agar culture remain sterile, and are differentiated mainly on the basis of vegetative characters. During a study of the occurrence of *Rhizoctonia solani* Kuhn in England, a number of isolates falling within the limits of the form genus *Rhizoctonia* regarding vegetative characters formed basidiospores freely on agar cultures. These isolates were afterwards identified as *Corticium praticola* Kotila[1], although the measurements of basidia, sterigmata and spores were all slightly larger than those given by Kotila.

This is the first record of this fungus from Great Britain, and the first confirmatory record of Kotila's original work. D. P. Rogers[2], in dealing with the genus in 1943, failed to accept the species due to absence of original material and lack of confirmatory isolations.

The fungus was obtained from four widely separated localities in England. At Slough and Bristol, soil was very heavily infested with the organism, and at Cheshunt and Leeds it was found causing foot rot of cucumber and rot of dahlia petioles and leaves respectively. It is probably of common occurrence and may have been isolated previously not only in England but also in other countries and included under *R. solani*. As supporting evidence for this suggestion, isolates closely agreeing with the English ones have been obtained from several soils in South Australia during 1951. Although these isolates have not yet been induced to form basidiospores, they have been temporarily classified as *C. praticola*.

C. praticola differs from *R. solani* in its thinner hyphal diameter (6–9 μ, *C. praticola*; 8–12 μ, *R. solani*), faster growth-rate (0·55 mm. per hour, *C. praticola*; less than 0·5 mm. per hour, *R. solani*), and by the white mealy appearance of its mycelium later turning greyish-brown, in contrast to the felt-like cinnamon-brown of *R. solani*.

C. praticola is pathogenic to sugar beet seedlings above 15° C. and to a wide variety of hosts, including lettuce, tomato, cabbage and dahlia, at temperatures of 23°–25° C. and above. This fact, together with its vigorous saprophytic growth, makes it a potential danger particularly if it becomes established in vegetable-growing areas. In South Australia the organism has caused severe losses of tomato seedlings being raised under warm conditions in nurseries.

As a laboratory organism, *C. praticola* is useful for teaching purposes. When grown on a soil extract agar with 0·1 per cent added sugar, the fruiting structures can be clearly demonstrated with little visual interference from sterile hyphæ. In view of its close similarity to *R. solani*, it may also prove a useful tool in aiding our understanding of the various isolates of *R. solani* and their relationship with *Corticium solani*.

The fungus was isolated while working in Prof. W. Brown's laboratory at the Imperial College of Science and Technology, London.

N. T. Flentje
Waite Agricultural Research Institute,
University of Adelaide.
April 17.

[1] Kotila, J. E., *Phytopath.*, **19**, 1059 (1929).
[2] Rogers, D. P., *Farlowia*, **1**, 95 (1943).

Isolation of Triploid *Saccharomyces cerevisiæ*

The production of tetraploids in a brewery yeast has been reported by Subramaniam and Krishna Murthy[1] and Mitra and Subramaniam[2], following treatment with acenaphthene and chrysene. These authors did not present genetic evidence to support their claim, which was based mainly on colony and other gross observations. Cytological evidence has recently been presented for a tetraploid with four chromosomes, derived from a "diploid two chromosome . . . strain"[3]. Tobias[4] studied a yeast isolated after acenaphthene treatment in terms of survival after X-irradiation, and concluded that the isolate was tetraploid. DeLong and Lindegren[5] have characterized certain strains of *Saccharomyces cerevisiæ* as triploid and tetraploid, based on the shapes of survival curves after ultra-violet irradiation. A paper by Lindegren and Lindegren[6] has recently appeared, describing the production of tetraploid yeast by crosses of diploids homozygous for complementary mating types. We wish to give a preliminary report on a procedure for the isolation of pure triploid clones of *S. cerevisiæ*.

A diploid clone was isolated (by the method of Pomper and Burkholder[7]) which required adenine and uracil for growth, that is, was homozygous for recessive alleles for adenine and uracil syntheses. This diploid was heterozygous for mating type (α and α of Lindegren and Lindegren[8]), and for genes involved in the syntheses of methionine and tryptophane. Haploid clones of both mating types, requiring methionine and tryptophane for growth (the same loci for which the diploid was heterozygous), were available to us. The diploid was mixed with both haploids (in separate tubes) by the 'mass mating' procedure of Lindegren and Lindegren[8]. After incubation for three days at 25° C., the cells were washed and plated on agar containing carbohydrate, nitrogen, vitamins and buffer, but lacking adenine, uracil, methionine and tryptophane. Under these conditions, neither the haploids nor the diploid should be able to grow, and, indeed, control plates had no colonies. However, a few colonies appeared on the plates from both 'crosses'. These were isolated as presumptive triploids. Since it was possible that we had merely isolated either doubly reverted diploids or haploids, it was necessary to carry out further tests to evaluate the assumption that these isolates were indeed triploids.

Neither the haploids nor the diploid employed in these crosses could themselves sporulate under our test conditions. The observation that the 'triploid' isolates sporulated lent support to the belief that the test isolates were, at least, different from the original components of the cross. Dissections were carried out on asci from the 'triploids' arising from both crosses. Examination of the mating-type behaviour of the ascospore isolates revealed that a number of them did not conjugate with tester stocks of either mating type.

In one ascus, two of the four spores mated, and two did not. The latter pair were found to sporulate; the former did not. The sporulating ascospores behaved as typical diploids and segregated for mating type, thus explaining the failure of the parental spores to mate. The conclusion appears justified that the parent culture had produced two haploid and two diploid clones, and further, that the parent was probably a triploid or its nuclear equiv-

alent. Additional supporting evidence will be presented in a subsequent, more detailed, report. It should also be noted that tetraploids have been isolated by an analogous procedure.

It is a pleasure to acknowledge the assistance of Mrs. K. M. Daniels and Mrs. D. W. McKee. This work was performed under contract No. *W*-7405-eng for the Atomic Energy Commission.

SEYMOUR POMPER

Biology Division,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee.
April 22.

[1] Subramaniam, M. K., and Krishna Murthy, S. N., *Proc. Ind. Acad. Sci.*, **30**, 185 (1949).
[2] Mitra, K. K., and Subramaniam, M. K., *La Cellule*, **53**, 7 (1949).
[3] Subramaniam, M. K., *La Cellule*, **54**, 145 (1951).
[4] Tobias, C. A., in Oberlin Symposium on Radiobiology, June 1950 (John Wiley and Sons, Inc., New York, 1952).
[5] DeLong, R., and Lindegren, C. C., *Bact. Proc.* (51st General Meeting), 63 (1951).
[6] Lindegren, C. C., and Lindegren, G., *J. Gen. Microbiol.*, **5**, 885 (1951).
[7] Pomper, S., and Burkholder, P. R., *Proc. U.S. Nat. Acad. Sci.*, **35**, 456 (1949).
[8] Lindegren, C. C., and Lindegren, G., *Ann. Missouri Bot. Garden*, **30**, 453 (1943).
[9] Lindegren, C. C., and Lindegren, G., *Proc. U.S. Nat. Acad. Sci.*, **29**, 306 (1943).

Apparent Fumigant Action of Non-volatile Insecticides in African Huts

DURING the course of experiments conducted by one of us (G. D.[1]) on the residual action of various insecticidal preparations applied to the interior of native-type African houses, a pronounced fumigant-type action was found in houses treated with preparations of DDT and dieldrin.

Since then, tests have been done (G. F. B.) by filtering the air in a hut sprayed with dieldrin wettable powder five weeks previously. The apparatus used consisted of fumigant chambers made from 1-lb. glass jars fitted with waxed bungs. Air was removed from the top of the jar through a tube by means of a filter pump; fresh air entered through an upright funnel and was delivered at the bottom of the jar. The funnel had a screwed ring by means of which a disk of filter paper cut to size could be firmly stretched over the mouth of the funnel. The whole apparatus was sealed with paraffin wax. To reduce control mortalities, the jars were lined with a rough-surfaced paper and a piece of moist cotton-wool was put in the jar, the air passing over this as it was delivered. The jars were also covered with a dark cloth. Owing to a breakage in transit, the control could not be run at the same time as the test, and was carried out separately in the field laboratory.

Air was sucked through the single jar at 90 litres/hr. for forty minutes, and as a filter one thickness of Whatman No. 1 filter paper used. The house to be tested had been sprayed five weeks before (November 26, 1951) with dieldrin wettable powder to give an estimated deposit of 40 mgm. dieldrin per square foot.

Twenty to forty female *A. gambiæ* and *A. funestus* mosquitoes were used in each test. Of the four trials carried out in the treated house, two were done with the funnel leaning against the wall in the darkest and the quietest corner, and two with the jar suspended just beneath the roof. In each of these positions one trial was made with the filter in position. The two other trials were done without filters; for the one near the wall, the filter-paper was simply removed, but when the jar was hung close to the roof the bung and funnel were taken off and the jar covered with mosquito gauze, the suction tube passing through this to the bottom of the jar.

Deaths 18 hours after exposure are given in the accompanying table.

		Number dead	Total	Percentage dead
Dieldrin with filter	(*a*) Wall	$3f$	$9g + 5f$	21
	(*b*) Roof	$2f$	$8g + 22f$	7
Dieldrin without filter	(*a*) Wall	$2g + 21f$	$5g + 37f$	55
	(*b*) Roof	$2g + 23f$	$2g + 23f$	100
Control		$5f$	$5g + 29f$	15

g = *A. gambiæ*. f = *A. funestus*.

Thus the apparent fumigant action is due to solid particles too large to pass the filter paper.

Further laboratory trials indicated that DDT and dieldrin wettable powders sprayed on to mud, plywood and glass all produce lethal particles. Thus an important source of such particles in a mud-walled hut may be the roof. However, mosquitoes caged close to the wall usually suffer higher mortalities than those suspended in the middle of the hut. The presence of lethal particles may help to explain why the efficacy of DDT insecticides on a practical scale, for example, against *A. gambiæ* and *A. funestus* in Mauritius[2] and *A. darlingi* in British Guiana[3], has been greater than might be expected from laboratory and semi-field trials[4,5]. Insects activated to flight by contact with DDT[6] either on the substrata or as airborne particles would pick up more airborne particles in a given time than if they remained at rest[7]. Dr. G. Giglioli has recently informed us that in British Guiana he has been able to detect airborne particles of DDT for up to two years after spraying a house with non-absorbent walls.

There remains the question of any possible danger to health from these particles when those of the newer insecticides are breathed in for a period of years. The manufacturers of dieldrin now take a more optimistic view than they originally did of its toxicity to human beings (information supplied by the Shell Chemical Co. of Africa). DDT has already been used for many years without reported cases of ill-effects from inhaling drifting particles in houses. Dieldrin is applied at 20 per cent or less of the rate at which DDT is used. Unless it is correspondingly more toxic, the risk of using this exceptionally efficient preparation appears small.

Our thanks are due to the Colonial Insecticide Committee for permission to publish this note.

G. DAVIDSON

Ross Institute,
Gower Street,
London, W.C.1.

G. F. BURNETT

Colonial Insecticide Research Unit,
Arusha, Tanganyika Territory.
Aug. 5.

[1] Davidson, G., *Nature*, **170**, 702 (1952).
[2] Dowling, M. A. C., Malaria Eradication Scheme, Maurittius, Annual Report for 1951.
[3] Giglioli, G., "Malaria, Filariasis and Yellow Fever in British Guiana" (Georgetown, 1948).
[4] Hadaway, A. B., and Barlow, F., *Bull. Ent. Res.*, **40**, 323 (1949).
[5] Thomson, R. C. M., *Nature*, **163**, 109 (1949).
[6] Kennedy, J., *Bull. Ent. Res.*, **37**, 593 (1947).
[7] David, W. A. L., and Bracey, P., *Bull. Ent. Res.*, **37**, 177 (1946).

An Extended Orcinol Test Specific for Ketose Sugars

The formation of coloured products when sugars are heated with orcinol and mineral acids has long been known[1,2], and the reaction has been used for the detection and estimation of various sugars and related compounds. Thus Vasseur[3] states that the absorption curves for the products formed from pentoses, aldo- and keto-hexoses and methyl pentoses all differ from each other, but that the colours are not stable. According to Nozoe[4], the colours formed are due to the formation of furfural derivatives, and several pigments are formed successively, the final result being dependent on the acid concentration employed.

It has now been found that ketoses or ketose-containing sugars yield products which are soluble in aqueous alkalis with an intense orange-brown colour; by carrying out the reaction in the manner described below, it is possible to distinguish between ketoses and other sugars, and even between ketoses and keto-aldonic acids.

The most satisfactory procedure was found to be as follows: In a test-tube are mixed 5 c.c. of a 0·5 per cent solution of orcinol in *n*-butanol, 1 c.c. of concentrated hydrochloric acid and about 0·2 c.c. of a 5 per cent solution of the sugar to be examined. The mixture is heated to boiling, allowed to stand for five minutes and then diluted with 10 c.c. of water. The diluted mixture is shaken, allowed to separate into two layers and the upper butanol phase removed. The colour of the latter is noted; the butanol layer is then shaken with 10 c.c. of 4 per cent caustic soda solution, the mixture allowed to separate, and the colour of the two phases noted.

The colours obtained by this procedure, with various types of sugar, are given in the accompanying table.

Sugar	Type	Colour in acid butanol phase	Colour in alkaline butanol phase	Colour in alkaline aqueous phase
Xylose Arabinose	Aldopentose	Pale blue	Nil	Nil or very pale brown
Glucose Galactose Maltose Lactose	Aldose C_6 or C_{12}	Pale yellow	Nil or very pale yellow	Yellow
Fructose Sucrose Raffinose	Ketose or ketose-containing compound	Emerald green	Yellow with green fluorescence*	Deep orange-brown
2-Ketogluconic acid 5-Ketogluconic acid	Ketoaldonic acid	Nil Greenish-yellow	Nil Orange†	Nil Yellow-orange
Galacturonic acid	Uronic acid	Nil	Nil	Nil

* Aqueous phase much more strongly coloured than butanol phase.
† Aqueous phase less strongly coloured than butanol phase.

Since 5-hydroxymethylfurfural was found to give the same colour reactions as fructose, and furfural the same reactions as the pentoses, it seems probable that these aldehydes are intermediately involved in the test, as claimed by Nozoe[4]. In the case of 5-ketogluconic acid, 5-carboxyfurfural is the most probable intermediate, while with uronic acids and 2-ketogluconic acid the conditions of the test are not sufficiently drastic to effect their conversion into furfural.

I am indebted to Prof. L. F. Wiggins for his interest in this work.

J. Howarth Williams

Department of Sugar Chemistry and Technology,
Imperial College of Tropical Agriculture,
Trinidad.

May 9.

[1] Bial, M., *Deut. Med. Woch.*, **28**, 253 (1902).
[2] Tollens, B., and Lefevre, K. U., *Ber.*, **40**, 4520 (1907).
[3] Vasseur, E., *Acta Chem. Scand.*, **2**, 693 (1948).
[4] Nozoe, T., *J. Chem. Soc. Japan*, **57**, 798 and 813 (1936).

A Sparing Effect by Formate or Methanol on the Impairment of Creatine Metabolism in Folic Acid Deficiency

In a recent communication[1] we reported on an involvement of dietary folic acid and vitamin B_{12} in creatine metabolism. The observations suggested that deficiencies of these vitamins were interfering with the economy of labile methyl groups. It has been established that the methyl groups of choline and methionine may undergo oxidative degradation to formate[2,3] and that the utilization of such metabolically derived formate for serine synthesis[4] and possibly in other single-carbon addition reactions such as nucleic acid formation[5] involves mediation of folic acid; this vitamin is also directly concerned with formate production from glycine[6]. It seemed possible, therefore, that the influence of folic acid on creatine formation might in part at least be due to a check on the drain of methyl to formate resulting in its increased availability for transmethylations (cf. ref. 6). A direct proof of this postulate was sought in the studies reported here on the influence by mass effect of administered formate on *in vitro* and *in vivo* creatine synthesis in mice suffering from folic-acid deficiency and in normal mice. Methanol was also used in place of formate since it functions better (see ref. 2) in the reverse step of formate reduction to methyl[2,3].

Twenty-four adult mice (inbred Swiss strain) were maintained on a folic acid – free purified ration[1] with 15 gamma per cent of vitamin B_{12} and 0·3 per cent iodinated casein. At the end of five weeks, when folic-acid deficiency could be inferred from observations on red and white cell counts and hæmoglobin contents, the animals were divided into groups of four (see table) receiving as supplements folic acid (10 gamma/mouse/day, orally) and sodium formate or methanol (1 mgm./mouse/day, intraperitoneally) with corresponding controls. Animals from each group were sacrificed at the end of 5, 8 and 9 days from the commencement of this grouping, for determinations of *in vitro* and *in vivo* creatine formation by earlier procedures[1]. The data for creatine

Group	Creatine		
	In vitro synthesis (γ per gm. of liver)	Per cent in wet muscle	In 24-hr. urine (mgm. per 100 gm. body-weight)
Basal diet (no folic acid)	116	0·257	1·57
Basal diet + formate	135	0·260	1·68
Basal diet + methanol	184	0·270	1·73
Basal diet + folic acid	203	0·288	1·80
Basal diet + folic acid + formate	210	0·293	1·86
Basal diet + folic acid + methanol	225	0·312	1·88

synthesis *in vitro* are exclusive of any Jaffe-reactive product that may have been formed from the added methionine by the D-amino-acid oxidase of the liver homogenates[7], since necessary controls[1] were run concurrently; creatine synthesis was further confirmed on paper chromatograms. Typical results are presented in the table and were essentially similar in the three periods of sampling.

It can be seen that the impairment in creatine metabolism brought about by folic-acid deficiency is partially restored by the administration of methanol; the effect due to formate is less pronounced. Similar results have been obtained in other studies on the N^1-methylation of nicotinamide[8].

The relatively less significant effect of methanol or formate supplementation in the groups receiving folic acid suggests that, if these compounds were functioning as methyl precursors, folic acid does not exert any direct effect on this synthetic step. This is in harmony with other observations (unpublished) on the probable direct non-participation of folic acid in methyl neogenesis from administered methanol and serine.

This work is supported by a grant from the Indian Council of Medical Research.

PREMA FATTERPAKER
URMILA MARFATIA
A. SREENIVASAN

Foods Section,
Department of Chemical Technology,
University of Bombay.
March 18.

[1] Fatterpaker, P., Marfatia, U., and Sreenivasan, A., *Nature*, **167**, 1067 (1951).
[2] See du Vigneaud, V., Verley, W. G. L., Wilson, J. E., Rachele, J. R., Ressler, C., and Kinney, J. M., *J. Amer. Chem. Soc.*, **73**, 2782 (1951).
[3] Sakami, W., and Welch, A. D., *J. Biol. Chem.*, **187**, 367, 379 (1950). Siekewitz, P., and Greenberg, D. M., *J. Biol. Chem.*, **186**, 275 (1950). Arnstein, H. R. V., *Biochem. J.*, **48**, 27 (1951).
[4] Plaut, G. W. E., Betheil, J. J., and Lardy, H. A., *J. Biol. Chem.*, **184**, 795 (1950). Lascelles, J., and Woods, D. D., *Nature*, **166**, 649 (1950).
[5] See Rege, D. V., and Sreenivasan, A., *Nature*, **166**, 1117 (1950). Woolley, D. W., and Pringle, R. B., *J. Amer. Chem. Soc.*, **72**, 634 (1950). Ruth, B. I., Benzamin, V., and Bergmann, E. D., *Arch. Biochem.*, **32**, 229 (1951). Drysdale, G. R., Plaut, G. W. E., and Lardy, H. A., *J. Biol. Chem.*, **193**, 533 (1952).
[6] Totter, J. R., Kelley, B., Day, P. L., and Edwards, A. R., *J. Biol. Chem.*, **186**, 145; **187**, 529 (1950). Totter, J. R., Volkin, E., and Carter, C. E., *J. Amer. Chem. Soc.*, **73**, 1521 (1951).
[7] Umbreit, W. W., and Tonhazy, N. E., *Arch. Biochem.*, **32**, 96 (1951).
[8] Fatterpaker, P., Marfatia, U., and Sreenivasan, A., *Nature* [**169**, 1096 (1952)].

Response of the Vaginal Epithelium of the Ovariectomized Mouse to the Systemic and Local Administration of Œstrone

IN the ovariectomized mouse, vaginal cornification follows the administration of œstrogens systemically (for example, by subcutaneous injection), or locally by their direct application to the vaginal epithelium. However, the median effective dose for all 'true' œstrogens is considerably lower for the local method of administration than for the systemic method[1].

Histological and histochemical observations on the process of cornification elicited by the two routes of administration have been made. No qualitative differences were noted. Freud[2], in a similar investigation with rats, also failed to detect any differences. However, there are temporal differences in the onset of cornification, and also its duration, between the two methods of administration. Emmens[1] has already reported that cornification is attained about a day earlier with local administration. His observations were obtained in assays in which the doses used were not expected to produce cornification in all animals. The phenomenon has been reinvestigated using two dose-levels both of which were calculated to elicit a positive response in all animals.

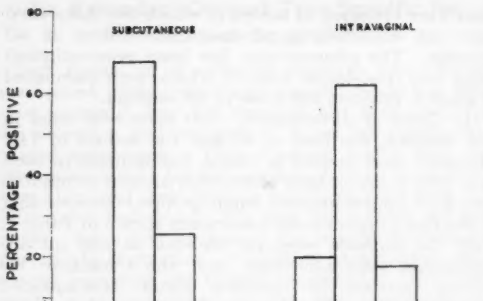
(1) *Onset of cornification.* 240 mice were used in two batches, the first of 95 and the second of 145. The mice were housed in boxes, five animals in each box. The boxes of each batch were divided at random into four approximately equal groups corresponding to the four experimental treatments shown in Table 1. Half the animals received œstrone in nut oil administered subcutaneously, and the remainder received œstrone in distilled water administered intravaginally. Two dose-levels were used for each route of administration (see Table 1). The lowest doses in each case are about 7–10 times the median effective doses reported elsewhere for this strain of mice[3]. A two-injection technique was used as described by Emmens[1]. Smears were taken night and morning, commencing the night after the second injection. The establishment of cornification was determined by the appearance of the first positive smear, that is, one consisting predominantly of cornified cells, and no leucocytes. Each smearing time was given a number to provide a basis for classification. The results from each experiment were combined and are shown in Table 1.

Table 1. TIME OF ESTABLISHMENT OF CORNIFICATION BY THE SUBCUTANEOUS AND INTRAVAGINAL METHOD, EACH AT TWO MAXIMAL DOSE-LEVELS OF ŒSTRONE

Smear time	Subcutaneous			Intravaginal		
	Low dose (0·5 μgm.)	High dose (2·5 μgm.)	Total	Low dose (0·005 μgm.)	High dose (0·025 μgm.)	Total
1	2	2	4	12	11	23
2	38	42	80	38	36	74
3	17	13	30	12	8	20
4	2	3	5	1	3	4

The results obtained with each route of administration were as follows: (i) *Subcutaneous.* Owing to the low group numbers at smearing times 1 and 4, adjacent groups must be combined for the statistical analysis. This gives a 2×2 contingency table. No statistically significant differences were found between the groups ($\chi^2_{[1]} = 0{\cdot}44$, $P > 0{\cdot}05$), showing that the dose-level makes no difference to the time of onset of cornification. (ii) *Intravaginal.* In this analysis the results from smearing times 3 and 4 were grouped, giving a 2×3 contingency table. No statistically significant differences were found between the groups ($\chi^2_{[2]} = 0{\cdot}06$, $P > 0{\cdot}05$), again showing that the dose-level makes no difference to the time of onset of cornification.

Since the dose-level was without influence on the time of cornification, the results for each method of administration were added together for each smearing time. This gives a 2×4 contingency table allowing a comparison to be made between each method of injection. The combined figures are given as marginal totals in Table 1. A statistically significant difference was found between the two methods ($\chi^2_{[3]} = 15{\cdot}70$, $0{\cdot}01 > P > 0{\cdot}001$). The results are illustrated graphically in the accompanying histogram. They show that the onset of cornification in the intravaginal method is approximately twelve hours in advance of the onset in the subcutaneous method. This confirms the finding of Emmens[1].



(2) *Duration of cornification.* Emmens[4] showed that the duration of cornification with the subcutaneous route of administration depends on the dose of œstrogen administered. The effect of dose on the duration of cornification in the intravaginal method has been investigated. Smears were taken from the intravaginal groups in the second batch of animals throughout the period of cornification. Table 2 shows the times when negative smears returned.

Table 2. Time of Reappearance of Negative Smears in the Animals Receiving Two Maximal Dose-levels of Œstrone Intravaginally

Smear time	Low dose	High dose
4	18	9
5	11	11
6	11	15

Although there might be a slight tendency for the effect of the high dose to persist for a longer period than the effect of the low dose, on statistical analysis no significant difference between the two distributions was detected ($\chi^2_{[2]} = 3{\cdot}30$, $P > 0{\cdot}05$). On the evidence available, therefore, there is no reason for supposing that dose-level influences the duration of cornification by the intravaginal method. However, it is possible that with wider dose intervals, such as those used by Emmens, differences in the duration of cornification would become apparent; this question requires further examination.

J. D. Biggers

Department of Veterinary Physiology,
University of Sydney.
April 28.

[1] Emmens, C. W., "Hormone Assay", Chapter 16 (Academic Press, New York, 1950).
[2] Freud, J., *Acta brev. neerl. Physiol.*, **9**, 11 (1939).
[3] Biggers, J. D. (in the press).
[4] Emmens, C. W., *J. Endocrinol.*, **1**, 142 (1939).

Two Forms of 1 : 2 : 3 : 5 Tetra-Acetyl D-Ribofuranose

In a recent communication, Davoll, Brown and Visser[1] have described two forms of 1 : 2 : 3 : 5 tetra-acetyl D-ribofuranose. The form first obtained had melting point 56°–58° and was probably identical with the compounds of Howard, Lythgoe and Todd[2], and of Bredereck and Hoepfner[3]. This substance changed spontaneously into another, melting point 85°, proved to be identical with the 1 : 2 : 3 : 5 tetra-acetyl D-ribofuranose of Zinner[4]. The transformation was reported to be accompanied by a change in specific rotation from $[\alpha]_D^{20} - 3{\cdot}6°$ to $- 13{\cdot}5°$ (in methanol).

Some time ago, I prepared this compound (using the method of Zinner[4]) in the lower-melting form (melting point 56·5°–57°). When a comparison with the higher-melting form (generously provided by Dr. Zinner, of Jena) was attempted, the whole of the material isomerized, and the form of melting point 56·5°–57° can no longer be prepared in this laboratory. This isomerization, however, proceeded without any significant change in specific rotation; $[\alpha]_D^{20}$ for the low-melting form $- 13{\cdot}2 \pm 1°$; for the high-melting form $- 12{\cdot}0 \pm 1°$ (both in chloroform). The case thus seems to be a simple (though very striking) one of dimorphism, and the speculations of Davoll *et al.*[1] regarding structural isomerism are probably unnecessary.

It would be of great interest, however, if workers in some laboratory uncontaminated with the higher-melting form would re-examine the transformation polarimetrically, since there is a definite contradiction between the results of Davoll *et al.*[1] and those I have obtained.

Kathleen R. Farrar

Chemistry Department,
University of Manchester.
July 29.

[1] Davoll, J., Brown, G. B., and Visser, D. W., *Nature*, **170**, 65 (1952).
[2] Howard, G. A., Lythgoe, B., and Todd, A. R., *J. Chem. Soc.*, 1052 (1947).
[3] Bredereck, H., and Hoepfner, E., *Ber.*, **81**, 51 (1948).
[4] Zinner, H., *Ber.*, **83**, 153 (1950).

Disadvantages of Race Mixture

In the modified Unesco statement on the nature of race, issued at the Fourth International Anthropological Congress in Vienna on September 7, we find the incautious affirmation that "there is no evidence that race mixture produces disadvantageous results from a biological point of view". To cite a single case, there is recent evidence[1] that sickle-cell anæmia, a fatal disease, occurs with much higher frequency in American Negroes having some white ancestry than in African Negroes of pure descent, although the latter show a much higher frequency of the sicklæmia trait, which is without symptoms.

Similarly, the *Rh*-negative gene, which is responsible for the death of countless Caucasian infants and fœtuses, has been traced to prehistoric crossing between the Basques and peoples speaking the Indo-European languages. These crosses probably began at least as early as the Neolithic; but their effects on the death-rate of European infants and fœtuses (erythroblastosis) are still unabated. Here is ample evidence that race mixture can be disadvantageous in its racial effects.

R. Ruggles Gates

The Athenæum,
London, S.W.1.
Sept. 9.

[1] Lehmann, H., *Nature*, **167**, 931 (1951).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 24

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Discussion on "Polymer-Solvent Interaction".*

CHEMICAL SOCIETY, OXFORD SECTION (in the Physical Chemistry Laboratory, South Parks Road, Oxford), at 8.15 p.m.—Dr. D. A. Dowden: "Industrial Catalysis" (Alembic Club Lecture). (All Fellows are invited.)

Tuesday, November 25

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Mr. W. A. Allen and Mr. P. H. Parkin: "The Acoustic Design of Auditoria". (Further Lectures on December 2 and 9.)

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Dr. C. F. Hickling: "The Expansion of Fisheries in the Colonial Empire".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting; at 6.30 p.m.—Papers on "Forensic Science".

SOCIETY OF INSTRUMENT TECHNOLOGY (joint meeting with the CONTROL SECTION, at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Symposium on "Control Valves".

Tuesday, November 25—Wednesday, November 26

INSTITUTION OF GAS ENGINEERS (at Church House, Westminster, London, S.W.1), at 10 a.m. each day.—18th Autumn Research Meeting.

Wednesday, November 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. George F. Underhay: "Raw Materials for Paper".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the SUPPLY and MEASUREMENTS SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. McDonald: "The Electrolytic Analogue in the Design of High-Voltage Power Transformers"; Dr. K. F. Sander and Mr. J. G. Yates: "The Accurate Mapping of Electric Fields with an Electrolytic Tank".

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Discussion on "Home Lighting".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the FOOD GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Rt. Hon. the Earl of Halsbury: "Science, Industry and Society".

Wednesday, November 26—Thursday, November 27

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1), at 10 a.m. each day.—Autumn General Meeting.

Thursday, November 27

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. S. E. Hollingworth: "Hunting Sulphur in the Andes".*

UNIVERSITY OF LONDON (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 3 p.m.—Prof. J. Elkes: "Some Uses and Limitations of Pharmacological Method in Psychiatric Research".*

UNIVERSITY OF LONDON (in the Chemistry Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. N. F. Mott, F.R.S.: "Dislocations and the Properties of Solids".* (Further Lectures on December 4 and 11.)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Colonel H. T. Jessop: "Photoelasticity and Aircraft Research".

Friday, November 28

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Presentation of the 29th Duddell Medal and Prize to Mr. C. Waller, and the presentation of the 8th Charles Vernon Boys Prize to Dr. B. Bleaney; Mr. C. Waller: "Some Topics concerning the Production and Application of Nuclear Emulsions"; Dr. B. Bleaney: "Paramagnetic Resonance at Low Temperatures".*

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. Herbert Addison: "Instruction and Research in Hydraulic Laboratories".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Derek J. Price: "Chaucer's Astronomy".

Saturday, November 29

BOTANICAL SOCIETY OF THE BRITISH ISLES (at the British Museum (Natural History), Cromwell Road, London, S.W.7), at 2.30 p.m.—Annual Exhibition Meeting.

BRITISH PSYCHOLOGICAL SOCIETY, SCOTTISH BRANCH (in the Psychological Laboratory, 12 University Gardens, Glasgow), at 2.30 p.m.—Dr. Sarah S. McIntyre: "A Study of National Prejudices"; Mr. John H. Chaplin and Mr. Robert C. Vallance: "Scientific Curiosity and Interest in relation to Ability and Achievement in School".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MATHEMATICS (preferably with a good honours degree and able to take lectures to honours degree standard)—The Registrar, Technical College, Sunderland (November 29).

ASSISTANT TEACHER (Grade B) IN BOTANY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (December 1).

CENSOR AND TUTOR IN SCIENCE in University College and PART-TIME LECTURER in the University—The Secretary, The University, 38 North Bailey, Durham (December 1).

LECTURER IN MECHANICAL ENGINEERING, and an ASSISTANT (Grade B) IN ENGINEERING, at Constantine Technical College—The Director of Education, Woodlands Road, Middlesbrough (December 5).

JUNIOR OBSERVER (with a good honours degree in astronomy, physics or mathematics)—The Director, The Observatories, Cambridge (December 6).

SCIENTIST (with a degree in engineering and M.I.M.E.) to take charge of a group responsible for applying the results of scientific research to the design of experimental machines in connexion with the underground mining of coal (Ref. TT/566), and a SCIENTIST, Grade II (preferably with a good geological background) to assist in research on basic underground mining processes involving the structure and physical properties of coal measure rocks (Ref. TT/567), at the Central Research Establishment, Isleworth, Middx—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (December 8).

SENIOR LECTURER or LECTURER IN MATHEMATICS at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (December 8).

ESTABLISHED GEOLOGIST in the Geological Survey—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 9).

SENIOR GEOPHYSICIST in the Bureau of Mineral Resources, Geology and Geophysics, Melbourne, principally to edit and attend to publication of geophysical reports, maps and plans; also to supervise the work of the drafting and library staffs—The Deputy High Commissioner, Australia House, Strand, London, W.C.2, endorsed for attention of 'The Senior Representative, Division of Industrial Development' (December 11).

ASSISTANT (with honours degree in biochemistry, agricultural chemistry, or equivalent qualifications) IN AGRICULTURAL BIOCHEMISTRY—The Secretary, The University, Aberdeen (December 12).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffs (December 15).

EXPERIMENTAL OFFICER (woman, with a University degree with chemistry or microbiology as a principal subject, or equivalent qualification) IN THE DOMESTIC PRESERVATION SECTION—The Secretary, Long Ashton Research Station, Bristol (December 15).

AGRICULTURAL ECONOMIST and ASSISTANT AGRICULTURAL ECONOMISTS, at Newton Abbot—The Registrar, The University, Bristol 8 (December 29).

LECTURER IN ELECTRICAL ENGINEERING at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 31).

LECTURER IN BIOCHEMISTRY (graduate in medicine or science) at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 3).

ASSISTANT LECTURER IN BOTANY—The Registrar, The University, Manchester 13 (January 5).

PRINCIPAL—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (January 16).

READER IN SOCIAL ANTHROPOLOGY at the Australian National University—The Administrative Officer in the U.K., 27 Russell Square, London, W.C.1 (January 19).

LECTURER or SENIOR LECTURER IN BOTANY at the University of Otago, Dunedin—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 30).

SCIENTIFIC ASSISTANT (Veterinary Officer) (M.R.C.V.S. or its equivalent and a knowledge of languages essential)—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey (January 31).

PROFESSOR AND HEAD OF THE DEPARTMENT OF ORGANIC CHEMISTRY, PROFESSOR AND HEAD OF THE DEPARTMENT OF POWER ENGINEERING, PROFESSOR AND HEAD OF THE DEPARTMENT OF CHEMICAL TECHNOLOGY AND CHEMICAL ENGINEERING, and a PROFESSOR OF MECHANICAL ENGINEERING—The Registrar, Indian Institute of Science, Bangalore 3, India (February 1).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary, The University, Edinburgh (February 23).

ASSISTANT LECTURER (with an honours degree in agricultural chemistry, biochemistry or physiology) IN AGRICULTURAL CHEMISTRY at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

ASSISTANT LECTURER (with an honours degree, and interested in the physical aspects of biochemistry) TO TEACH CHEMISTRY AND PHYSICS, and to co-operate in the research work of the Department—The Secretary, Royal Technical College, Glasgow.

BIOLOGICAL ASSISTANT (with a B.Sc. in either biology or physiology) IN THE COURTAULD INSTITUTE OF BIOCHEMISTRY—The Secretary, Middlesex Hospital Medical School, London, W.1.

CHEMIST of B.Sc. (Special) standard, to take part in an investigation of urinary steroids in clinical cases—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1.

ELECTRICAL ENGINEER for design work on large capacity 11 KV and LT factory installations, and for work associated with steam boiler plant, compressed air installations, cranes and machine tools—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, quoting 390.

EXPERIMENTAL OFFICERS at R.A.F. Signals Establishments :—at Ruislip, for general experimental work and tests in connexion with design of radio communication and radar systems (three posts); at Medmenham, for installation design of airfield communications and landing aid systems, equipment investigations and siting problems (six posts), for design of installations for large radio receiving and transmitting stations (one post), for design of aerial and feeder systems (one post), for design, development or test of prototype mobile and portable radio and radar installations (six posts), for reconstruction of a radar landing aid and organization of associated experimental investigations (one post); at Watton, Norfolk, for development of highly specialized radio and radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.416/52A.

HEAD STATISTICIAN for the supervision of the Association's varied statistical and mathematical work, and carrying out and reporting on anthropometric work, field trials of footwear, etc., and a CHEMIST (young) and a PHYSICIST (young) for work on footwear production and wear problems, and shoe materials and other products used in the industry—The Director, British Boot, Shoe and Allied Trades Research Association, Rockingham Road, Kettering, Northants.

LECTURER IN CHEMISTRY—The Acting Registrar, University College, Exeter.

METALLURGISTS to study problems in the casting, fabrication and joining of non-ferrous metals—The Research Manager, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

PHYSICAL CHEMIST for research on surface activity and other phenomena related to detergents, etc. (ability to apply experimental results to practical wool scouring problems is of importance)—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

PHYSICIST for work on physical problems related to biological effects of high energy neutrons—The Director, Radiobiological Research Establishment, Harwell, Didcot, Berks.

RESEARCH ASSISTANTS (with a degree in metallurgy or chemistry) to work on a study of slag inclusion in steels, or other agreed chemical or metallurgical problem—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

SCIENTIFIC ASSISTANT (University degree in natural science and knowledge of languages essential)—The Director, Commonwealth Bureau of Animal Health, Weybridge, Surrey.

SENIOR EXPERIMENTAL OFFICER for development of calibration procedure for radio test equipment and preparation of calibration publications, and ASSISTANT EXPERIMENTAL OFFICERS for the calibration of transfer standards involving (*a*) frequency and pulse measurements or (*b*) bridge and miscellaneous measurements, at an R.A.F. Signals Experimental Establishment in Bedfordshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.415/52A.

SENIOR SCIENTIFIC OFFICER at London headquarters of the Ministry of Supply, for the assessment of the performance of supersonic aircraft projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.295/52A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Rothamsted Experimental Station. Report for 1951. Pp. 212. (Harpenden : Rothamsted Experimental Station, 1952.) 7*s.* 6*d.* [198

Bolton and District Hospital Management Committee. Report for the Period 5th July 1948 to 31st December 1951. Pp. 56. (Bolton : Bolton and District Hospital Management Committee, 1952.) [198

Bulletin of the British Museum (Natural History). Zoology, Vol. 1, No. 8 : The 'Manihine' Expedition to the Gulf of Aqaba, 1948–1949. Pp. 151–252+plates 22–32. 25*s.* Zoology, Vol. 1, No. 9 : On the Species and Races of the Yellow Wagtails from Western Europe to Western North America. By C. H. B. Grant and C. W. Mackworth-Praed. Pp. 253–268+plates 33–35. 5*s.* (London : British Museum (Natural History), 1952.) [198

The Air Almanac, 1953, January–April. (Air Publication 1602.) Pp. 242+A.56. (London : H.M. Stationery Office ; Washington, D.C. : United States Naval Observatory, 1952.) 10*s.* [198

Manchester Public Libraries. 100th Report of the Libraries Committee, 1951–52. Pp. ii+55+10 plates. (Manchester : Central Library, 1952.) [198

Philosophical Transactions of the Royal Society of London. Series A : Mathematical and Physical Sciences. No. 892, Vol. 245 : The Reduction of Star Sets. By C. A. Rogers. Pp. 59–93. 8*s.* No. 893, Vol. 245 : Electronic Wave Functions, 6, Some Theorems facilitating the Evaluation of Schrödinger Integrals of Vector-coupled Functions, by S. F. Boys ; 7, Methods of Evaluating the Fundamental Coefficients for the Expansion of Vector-coupled Schrödinger Integrals and some Values of These, by M. J. M. Bernal and S. F. Boys ; 8, A Calculation of the Ground States Na^+, Ne and F^-, by M. J. M. Bernal and S. F. Boys. Pp. 95–154. 13*s.* (London : Cambridge University Press, 1952.) [198

Philosophical Transactions of the Royal Society of London. Series B : Biological Sciences. No. 640, Vol. 237 : Fat Combustion and Metabolic Rate of Flying Locusts (*Schistocerca gregaria* Forskål). By T. Weis-Foch. Pp. 36. 8*s.* 6*d.* No. 641, Vol. 237 : The Chemical Basis of Morphogenesis. By A. M. Turing. Pp. 37–72. 8*s.* (London : Cambridge University Press, 1952.) [198

University of Birmingham : Institute of Education Library. Catalogue (Supplement No. 1, Feb. 1951–Mar. 1952). Pp. 83. (Birmingham : The University, 1952.) [198

Institute of Seaweed Research. Annual Report for 1951. Pp. 36. (Inveresk : Institute of Seaweed Research, 1952.) [198

City and County of Bristol : The City Museum. Report of the Committee for the Year ended 31 December 1951. Pp. 16+4 plates. (Bristol : City Museum, 1952.) [198

Flora of Tropical East Africa. Editors : Dr. W. B. Turrill and E. Milne-Redhead. (Published under the authority of the Secretary of State for the Colonies.) Part 3 : Marantaceæ. By E. Milne-Redhead. Pp. 12. (London : Crown Agents for the Colonies, 1952.) 1*s.* 3*d.* [208

Department of Scientific and Industrial Research. Report of the Food Investigation Board with the Report of the Director of Food Investigation for the Year 1951. Pp. iv+39. (London : H.M. Stationery Office, 1952.) 1*s.* 6*d.* net. [208

Royal Institute of Chemistry. Lectures, Monographs and Reports 1952, No. 3 : The Production of Sulphuric Acid from Calcium Sulphate. By Dr. W. L. Bedwell. Pp. 21. (London : Royal Institute of Chemistry, 1952.) 5*s.* net. [208

Other Countries

Indian Council of Medical Research. Technical Report of the Scientific Advisory Board for the Year 1951. Pp. xii+271. (New Delhi : Indian Council of Medical Research, 1952.) 1 rupee. [198

Indian Association for the Cultivation of Science. Annual Report for 1951–52. Pp. ii+40. (Calcutta : Indian Association for the Cultivation of Science, 1952.) [198

Indian Forest Bulletin No. 154 : The Seasoning Behaviour of Indian Timbers, Part 1. By M. A. Rehman. Pp. 5+1 plate. 8 annas ; 9*d.* Indian Forest Bulletin No. 156 : Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board, Part 6, Writing and Printing Papers from Paper Mulberry (*Broussonetia papyrifera*). By Dr. R. V. Bhat and Dr. S. R. D. Guha. Pp. ii+10. 9 annas ; 10*d.* (Delhi : Manager of Publications, 1952.) [198

Indian Forest Leaflet No. 127 : Agar Oil from the Wood of *Aquilaria agallocha* Roxb. By Sadgopal and B. S. Varma. Pp. ii+8+6 plates. (Delhi : Manager of Publications, 1952.) 8 annas ; 9*d.* [198

Canada : Department of Mines and Technical Surveys, Mines Branch. Sulphur and Pyrites in Canada. By T. H. Janes. (Memorandum Series No. 118.) Pp. ii+103. (Ottawa : Department of Mines and Technical Surveys, 1952.) [198

Materiæ Vegetabiles : Acta Culturæ et Præparationis Plantarum (Organ of the International Commission for Plant Raw Materials). Editors : C. Regel and Fr. Tobler. (Quarterly.) Vol. 1, No. 1, July. Pp. 128. (Den Haag : Dr. W. Junk, 1952.) 40 Dutch guilders per Vol. [198

The Allegheny Observatory of the University of Pittsburgh. Pp. 12. (Pittsburgh : Allegheny Observatory, 1952.) [198

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Scientifique No. 52 : Les associations végétales de la Plaine de la Ruzizi (Congo Belge) en relation avec le milieu. Par R. Germain. Pp. 321+43 plates. (Bruxelles : Institut National pour l'Étude Agronomique du Congo Belge, 1952.) 180 francs. [198

Sveriges Geologiska Undersökning. Ser. Ca, Nr. 21 : Beskrivning till jordartskarta över Kopparbergs län. Av G. Lundqvist. Pp. 213. (Stockholm : Kartografiska Institutet-Esselte AB., 1951). 20 kr. [198

Observatoire de Paris : Section d'Astrophysique, à Meudon. Cartes synoptiques de la chromosphère solaire et catalogue des filaments de la couche supérieure. Par L. D'Azambuja et R. Servajean. Pp. 144. (Meudon : Observatoire de Paris, 1952.) [198

East Africa High Commission. Virus Research Institute Annual Report, 1951. Pp.iii+23. (Nairobi : Government Printer, 1952.) [198

South Australia : Institute of Medicine and Veterinary Science. Thirteenth Annual Report of the Council, July 1950–June 1951. Pp. 49. (Adelaide : Institute of Medicine and Veterinary Science, 1952.) [198

Scientia International : Edition in Interlingua de Science News Letter. (Monthly.) Vol. 1, No. 1, Julio. Pp. 8. (Washington, D.C. : Science Service, 1952.) 2 dollars per year. [198

Bulletin of the American Museum of Natural History. Vol. 99, Article 4 : New and Little-known False Scorpions (Arachnida, Chelonethidæ) from Monterey County, California. By Joseph C. Chamberlain. Pp. 259–312+plates 19–20. (New York : American Museum of Natural History, 1952.) 75 cents. [198

United Nations. Housing and Town and Country Planning Bulletin 6 : Housing in the Tropics. Pp. 148. (New York : United Nations ; London : H.M. Stationery Office, 1952.) 1.50 dollars ; 11*s.* [198

Parliament of the Commonwealth of Australia. Third Annual Report of the Commonwealth Scientific and Industrial Research Organization for the year ended 30th June 1951. Pp. 167. (Canberra : Commonwealth Government Printer, 1952.) 9*s.* 6*d.* [198

Harvard Meteorological Studies. No. 9 : The Climate of Blue Hill according to Air Masses and Winds. By Photios P. Karapiperis. Pp. 105. (Cambridge, Mass. : Harvard University Press, 1951.) 1.25 dollars. [198

Infertility Disease in Sheep grazing Subterranean Clover. Pp. 8. (Melbourne : Commonwealth Scientific and Industrial Research Organization, 1952.) [198

Records of the South Australian Museum. Vol. 10 : The Scrub-Typhus and Scrub-Itch Mites (*Trombiculidæ*, Acarina) of the Asiatic-Pacific Region. Edited by the Museum Director. Part 1 (Text). Pp. iv+436. 42*s.* Part 2 (Plates). Pp. 437–673 (118 plates). 21*s.* (Adelaide : South Australian Museum, 1952.) [198

Beihefte zum Geologischen Jahrbuch. Heft 4 : Entölung von Erdöllagerstätten durch Sekundärverfahren. Von Walter Rühl. Pp. xi+285. 20 D. marks. Heft 5 : Gesichtspunkte zu einer palaobotanischen Gesellschaftsgeschichte (Soziogenese). Von Robert Potonié. Pp. v+116. 6.50 D. marks. (Hannover : Amt für Bodenforschung, 1952.) [208

Malayan Forest Records. No. 17 : Pocket Check List of Timber Trees. By J. Wyatt-Smith. Pp. v+182. (Kuala Lumpur : Forest Department, 1952.) 3 dollars ; 7*s.* 6*d.* [208

Fisheries Research Board of Canada. Bulletin No. 89 : Marine Oils with particular reference to those of Canada. Edited by the late B. E. Bailey. Revised from Bulletin No. 59 with the editorial assistance of N. M. Carter and L. A. Swain. Pp. xiii+413. (Ottawa : Fisheries Research Board of Canada, 1952.) 3 dollars. [258